

# Service Manual

## GSM Products

**PCH-D600**  
**PCM-D300**

Handportable

Mobile

Accessories: (only available as finished product)

PCH-D600C	Handportable with standard car kit PCA-410
PCA-400	Transportable kit for PCM-D300
PCA-410	Standard car kit for PCH-D600
PCA-411	Battery 700 mAh (PCH-D600)
PCA-412	Battery 1500 mAh (PCH-D600)
SLN2600A	Rapid Charger (PCH-D600)
SLN2604A	Travel Charger (PCH-D600)
SLN3043A	Battery Saver (PCH-D600)
SAF4630A	Antenna (PCH-D600)
SNN4067A	Battery 2300 mAh (PCM-D300)
SPN4046A	Rapid Charger (PCM-D300)
CCPN4013A	AC Power Supply (PCM-D300)
SAF4300A	Antenna (PCM-D300)
SLN7340A	Carrying Strap (PCM-D300)

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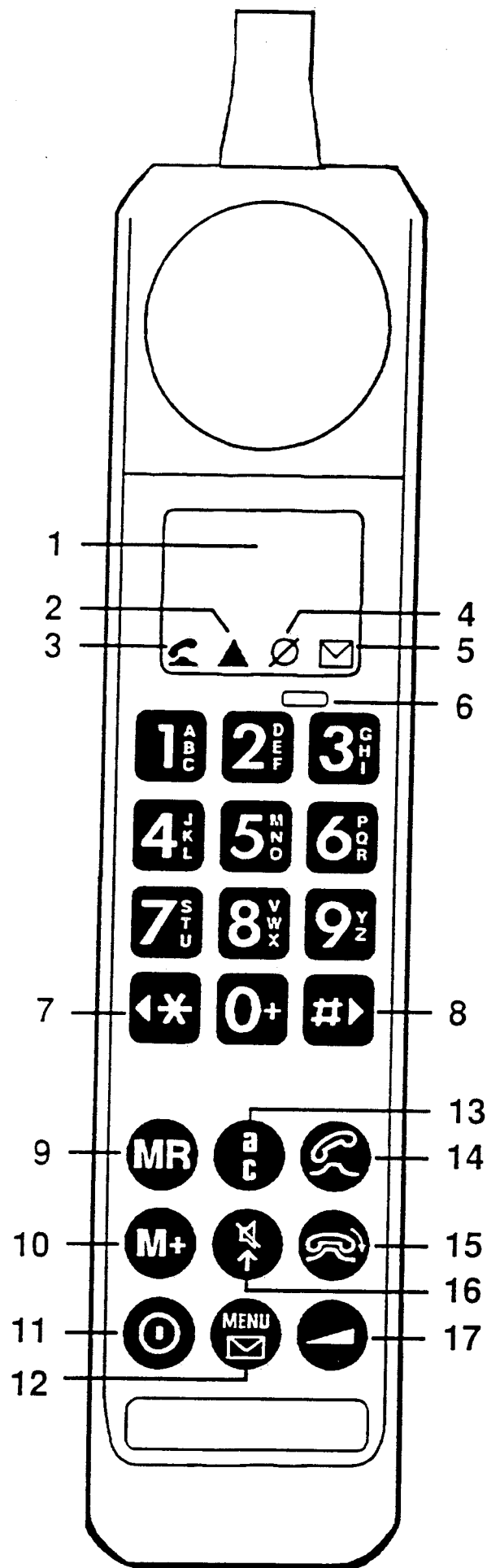
## **CONTENTS**

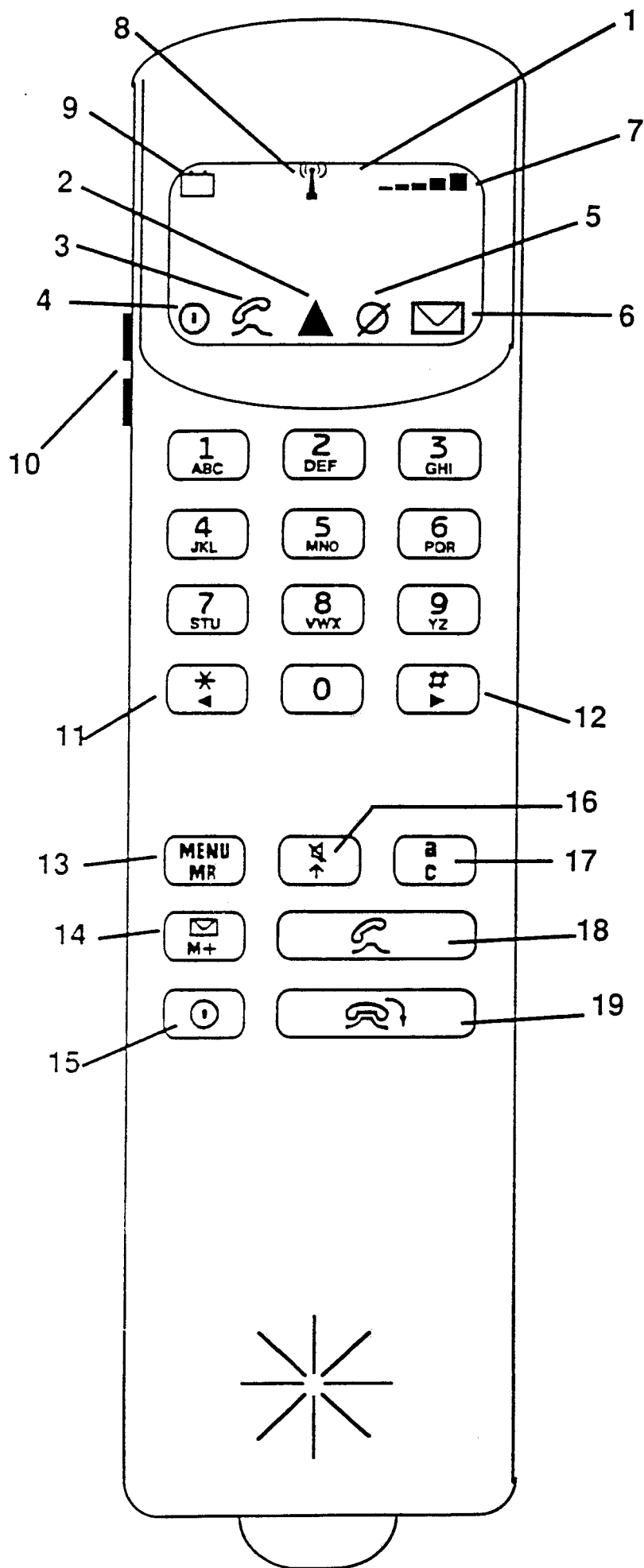
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# ESSENTIAL INFORMATION

## INTRODUCTION









This cellular telephone is designed for the Pan-European GSM system. Using this telephone makes it possible to contact any telephone in the world, provided you are in an area covered by the GSM system. The cellular telephone does not contain your GSM-subscriber number, this information is contained on your SIM card supplied by your local service provider. All billing will be registered, when the conversation takes place, to the subscriber number on the SIM card, which is inserted in the telephone.

## DISPLAY, INDICATORS AND KEYPAD

Number refers to PCH-D600

Number between brackets refers to the PCM-D300






Icons listed hereafter refer to buttons on the telephone as follows:

	-->	
	-->	
	-->	
	-->	


### Display

- (1) The 16-character display is used to show telephone numbers, short numbers and messages which inform you of the operation of the telephone. When the display is not in use for other purposes it will show the country code and the identity of the service provider.

### Indicators





















- (2)  Roam  
*Cont. light:* You are registered on a preferred system different from your home system.  
*Flashing:* You are registered on a non-preferred system.
- (3)  In use  
*Lights up,* when a call is in progress.
- (5)  No Service  
*Fixed light:* indicates that the telephone is outside any system coverage  
*Flashing:* indicates that the telephone is in area with a coverage, but is not registered with the system. You are able to place emergency calls using the special GSM emergency number 112, but you are unable to place / receive ordinary calls.
- (6)  Short Message  
The Short Message feature is not available on this model. This phone cannot be upgraded to support this feature.
- (4)  Power On  
*Lights up,* when the telephone is on.

## Volume Keys

- 17 (10) The volume key adjusts the earpiece and ringer volume levels. Holding down the volume key will either increase or decrease the volume until the key is released.  
For PCM-D300 only:  
*To adjust speaker volume:* operate the volume buttons when the handset is in the hang-up cup.  
*To adjust earpiece volume:* operate the volume buttons with the handset out of the hang-up cup.  
*To adjust ringer volume:*  and operate the volume buttons.

## Keypad

The keypad and the display are lit whenever the telephone is switched on. The upper portion of the keypad, 12 keys, is used for telephone numbers and letter entries. The lower portion of 9 (7) keys is used to enable specific functions.

7. (11)  Scroll backward in memory/menus
8. (12)  Scroll forward in memory/menus
9. (13)  Memory recall  
Press , to recall last number entered  
Press , followed by the short number you want to recall from memory.
10. (14)  Store  
Used when storing telephone numbers into the memory and to confirm choices in menus.
11. (15)  On/Off  
The  lights up (green on) when the telephone is on.
12. (14)  Menu/SMS  
*Menu*  
Initiates selection of features in the menus. Selected by pressing    
*Short Message Service (SMS)*  
The SMS feature is not available on this model. This phone cannot be upgraded to support this feature.
13. (17)  Letter entry/Clear  
*Letter entry*  
Letter entry is used when programming and recalling names with short-numbers  
Enabled pressing    
*Clear*  
Short press on  clears last digit  
Long press on  clears entire display.
14. (18)  Send  
Initiates call to the entered number. Answers incoming calls.
15. (19)  End  
Terminates calls
16. (16)  Mute  
Switches the microphone off/on during conversation.  
 Secondary functions  
Initiates the following functions:  
Menu, letter entry, adjustment of ringer volume and adding of international prefix.



# BASIC OPERATION

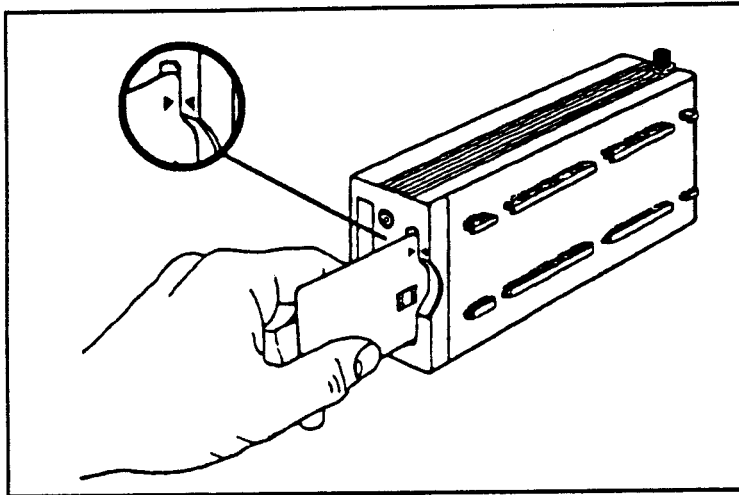
## About the SIM Card

Your network service provider has provided you with a subscription card generally known as a **Subscriber Identity Module Card** or **SIM Card**. The **SIM Card** is your personal key to accessing **GSM** services and contains all of your personal data including:

- subscriber number,
- home system,
- services subscribed to,
- PIN and Unblocking codes.

Your valid **SIM Card** must be correctly inserted into the card reader to access services.

## Inserting the SIM Card



The **SIM Card** may be inserted in the card reader located on the transceiver either before or after turning the telephone on.



### Inserting the SIM Card

If the **SIM Card** is missing or not correctly inserted, e.g. inserted upside down or backwards, the display reads:

INSERT CARD	Action: Insert SIM Card.
----------------	-----------------------------

CHECK CARD	Check for proper orientation and re-insert the SIM Card.
---------------	--

## On/Off

Switch on:  

If the **SIM Card** is not already inserted the display will prompt you to do so. The telephone then checks the validity of the **SIM Card**. *If the validation is OK*, the display may show:

ENTER	PIN	This indicates that the <b>SIM Card</b> is protected by a <b>PIN Code</b> . See the section, "Entering the <b>PIN Code</b> ."
-------	-----	---

ENTER	UNLOCK	CODE	This indicates that the telephone is protected by an electronic lock.
-------	--------	------	---

To unlock:

Unlock-Code .

See the section, "Electronic Lock".

If a problem exists with the SIM Card, the display shows one of the following messages:

BLOCKED See the section, "Unlocking the SIM Card".

BAD CARD or ,then SEE SUPPLIER

Please seek help from your service provider.

Switch-off:

After switch-off there may be a 2-3 second delay before it is possible to switch-on again.

## Entering the PIN Code

PIN is an abbreviation of Personal Identification Number. The PIN Code is a 4 to 8 digit code which protects your SIM Card from unauthorized use. The first PIN Code is selected by the SIM card provider. It may be changed or disabled. See the sections, "Changing the PIN Code" and "Disabling the PIN Code". If the SIM card is protected by a PIN Code, the display shows: ENTER PIN

Each time the telephone is switched on or the SIM card is inserted, you must enter:

PIN-Code

The PIN Code will be displayed as stars. If you make a mistake while entering the PIN Code, you may correct it by

If the PIN Code is accepted, the display shows: OK

If the PIN Code is not accepted, the display shows: WRONG PIN followed by ENTER PIN and you must re-enter the PIN Code.

If you do not succeed after three attempts the display shows: BLOCKED and the SIM card is blocked for further use until it has been unblocked by a special unblocking procedure. See the section, "Unlocking the SIM Card".

## Electronic Lock

The electronic lock protects your phone from unauthorized use. If locked, a three digit unlock code must be entered before the telephone can be used. If the display shows: ENTER UNLOCK CODE the telephone is protected by the electronic lock.

To unlock:

Unlock Code .



To lock:

If you want to change the unlock code see the section, "Changing the Unlock Code".

Note: Upon delivery the unlock code is set to 123. If you forget the unlock code, the electronic lock will not prevent you from entering menu mode to access the display/change unlock code option. Your security code will be required to change the unlock code.

## Placing a Call

When the  indicator is off, you may place a call as follows:

 Telephone no. (max. 20 digits) 

Lift handset and converse when answered.

End conversation by:

Replacing the handset, or  .

Also see the section, "Handsfree calls".

If a call is temporarily interrupted, the display may show: **RETRYING**

The GSM system will automatically re-connect the call if possible.



## Receiving a Call

When the telephone is called, the alert signal for incoming calls is heard.

*If the handset is in the hang-up cup:*

Answer by lifting the handset.

*If the handset is not in the hang-up cup:*

Answer by  .

End the conversation by:

Replacing the handset or  .

To stop alert signal without answering  .

Also see the section, "Handsfree Calls."

## ADVANCED CALL PLACEMENTS

### Handsfree Calls



*Outgoing calls:*



The handset must be in the hang-up cup. When the  indicator is off, you may place a call as follows:

 Telephone number  Direct conversation to the microphone.



End the conversation by:  .

*Incoming calls:*

The handset must be in the hang-up cup. When the telephone is called, the alert signal for incoming calls is heard. Answer by:   or any of the 12 upper keys



Direct conversation to the microphone. End the conversation by:  .

*Switching from Hands Free to Handset:* - Lift handset.

*Switching from Handset to Hands Free:*   ,place handset in hang-up cup.

### Automatic Answer

This feature allows you to reply to an incoming call without pressing any keys. *How to operate:*

The handset must be in the hang-up cup. When the telephone is called, the alert signal for incoming calls rings twice. The Hands Free microphone and loudspeaker are automatically switched on. Direct conversation by:  .

To enable/disable the feature:      .

## Automatic Redial

If a call attempt is unsuccessful, you may enable an automatic redial procedure. The telephone will then initiate multiple redial attempts until the call is connected or the redial procedure timed out.

*How to operate:* After a failed attempt, such as subscriber busy,   Before ending the call

The display will show: REDIAL as long as the automatic redial procedure is active.

*To cancel the automatic redial procedure:*  




## International Calls

Just like using the ordinary telephone system, you must add an international prefix before dialling the country prefix and the telephone number. The international prefix will automatically be added if you use this feature.

*How to operate*    (display shows + ) country prefix, telephone number 

Note that it is possible to store the   sequence in the short-number memory and still have the maximum of 20 digits.

## Emergency Calls

Emergency calls may be placed in two ways.     

*To dial the GSM emergency number 1 1 2 ,*

This call may be initiated with or without a SIM card inserted and despite electronic lock activation. The call is directed to a central emergency operator if the  indicator is either flashing or off.

*To dial the local emergency number* of the ordinary telephone system,

 Local emergency number 

The SIM card must be inserted and the  indicator is switched off. This call is completed like any ordinary call.

## SHORT-NUMBERS

The telephone has storage locations (referred to as short-numbers) for 100 telephone numbers and names which can be used to quickly dial frequently called telephone numbers. Each location can hold a telephone number up to 20 digits in length and a name up to 16 characters long. Short-numbers stored in the telephone are labelled from 1 through 100.

The SIM card may be capable of storing additional short-numbers. Your card provider will inform you of your card's capacity for storing short-numbers. SIM card short-numbers are labelled from 101 and up. For convenient recall, you may store your own telephone number into a short number, which is easy to remember e.g. (1 or 101).

## Short-number Programming

Programming a name and a number: Name

Telephone number Short-number

Programming without a name: Telephone number Short-number

Below you will find a more detailed explanation and examples of the short-number programming.

### Entering a name

Entering first character (such as "N") and hold down.

Display will show: M-N-O-5-M-N-...

Release key when character is shown. Pressing a new key will cause cursor to move next position. Repeat the procedure for next character. You may also select the character by pressing the key repeatedly.

To move the cursor.

To correct mistakes:

### Entering the Short-number

If you have no preference for a particular short-number, as the short-number. The telephone number and name will then automatically be stored in the next available short-number location. This feature is most often used when programming short-numbers with names. If you want the next available short-number location in a particular decade like the fifties, as the short-number.

If you want a specific short-number like 2,

### Programming Examples

Example no. 1:

Short-number:

Name:

Telephone no.:

This is what you do:

and hold  
 and hold  
 and hold  
 and hold

Next available.

Peter

1 3 5 7 9 2 4

Action:

Enter Letter mode

Select "P"

Select "E"

Select "T"

Select "E"

Select "R"

Alpha-Modus deaktivieren

Store

Next available\*

\*Entering will speed up storage. To confirm storage the display shows, for short-

number 1: STORED  
 AT 1

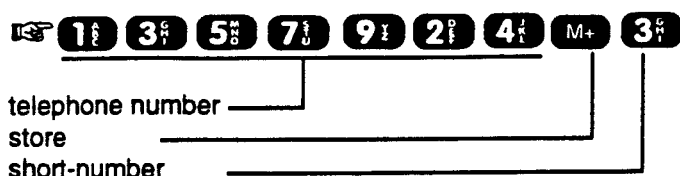
If the memory is completely full the display shows: FULL

### Example no. 2:

Short-number: 3

Name: -

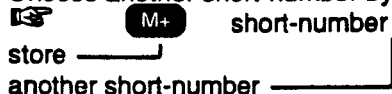
Telephone no.: 1 3 5 7 9 2 4



If the selected short-number is unoccupied the display shows: **STORED AT 3**

If the selected short-number is occupied the display shows: **3 IN USE**

Choose another short-number by:



## Short-number Recalling/Dialling

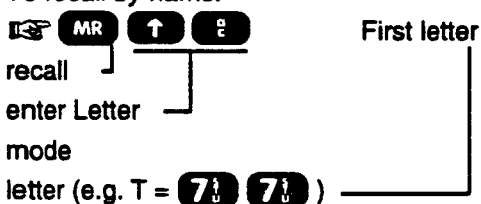
Short-numbers can either be recalled by name or by the short-number itself.

*To recall by the short-number:* MR Short-number.

Te (if any), short-number and telephone number will appear in the display. When the short-number is recalled you can:

- MR Review the recalled short.-number,
- #> scroll forward in short-numbers,
- <# scroll backward in short-numbers,
- Call call the recalled short-number,
- Clear clear the display.

*To recall by name:*



The name, short-number and telephone number will appear in the display. When recalled you can

- MR Review the recalled short-number,
- #> scroll forward in alphabetic order,
- <# scroll backward in alphabetic order,
- Call call the recalled short-number,
- Clear clear the display.

## Speed Dialling

It is possible to dial a short-number directly from memory. This is done as follows:



when the call is answered lift the handset. The called number is displayed.

## Short-number Clearing

Recall the short-number. Check that it is the number you want to clear.

If OK, ( If not ) The display then shows: CLEAR?

Confirm by ( otherwise )

## ADVANCED INFORMATION 2

### MEMORY FEATURES

#### Notepad

To store a telephone number during conversation, simply enter the number and end the conversation the usual way. You may next call the telephone number or store it as a short number.

Call the number by:

Store the number by: short-number Recall the number by:

#### Last number Dialed

Recall the number by: Call the recalled number by:

## SYSTEM REGISTRATION

### Automatic Roaming

The SIM Card memory contains space for a list of "preferred" service providers. If coverage on your home system becomes unavailable, the telephone will automatically try to establish contact with one of the first eight preferred service providers on this list. This is done in the order that they are listed. If automatic roaming is successful, the ▲ indicator will light up indicating that you are registered on a preferred system different from your home system. If service from one of the first eight preferred service providers is not available, the display shows:

SELECT  
SERVICE

To defer service selection:

To see a list of available service providers in the area where you are located:

The display shows the first service provider on the list. Providers are listed in order of decreasing signal strength.

Scroll forward in the list:

Scroll backward in the list:

Select displayed service provider:

If you are accepted by the system, the display will show the service provider code and the ▲ indicator will start flashing indicating that you are registered on a non-preferred system.

If you are not accepted by the system, the ⌀ indicator will flash. You may then continue as described in the section, "Manual Roaming."

## Manual Roaming

You may manually select a service provider from a list of those providing coverage at your immediate location. *To see the list of available service providers:*

Providers are listed in order of decreasing signal strength.

The display shows the first service provider as: 1\*234-01

Manual List Number \_\_\_\_\_

Star = Preferred Provider \_\_\_\_\_

Blank = Non-Preferred Provider \_\_\_\_\_

Service Provider Code \_\_\_\_\_

The lower line of the display may show the name of the service provider or the country abbreviation with the network number. The procedure for scrolling/selecting is described in the section, "Automatic Roaming."

## Displaying the Preferred List

*To see the list of preferred service providers:*

The display shows the first service provider on the list.

1\*234-01

Position on list

Service Provider Code

Scroll forward in the list:

Scroll backward in the list:



Where no service provider has been programmed the display will show: 7

To programme a service provider see the section, "Changing the Preferred List".

## Changing the Preferred List

Note: A list of international service providers and their codes can be obtained from your service provider. Enter preferred list and scroll to the position you want to change as described in the section, "Displaying the Preferred List".

*To change the displayed service provider:* Service Provider Code.

Example: Service Provider Code = 234-01

to scroll to position

*Clear the displayed service provider:* Check that it is the service provider you want to clear.

If OK, (If not ). The display then shows:

CLEAR? Confirm by (otherwise ).

## MENU OPERATION

Menu operation allows you to select and cancel features by following the prompts in the display.

*To enter menu mode:*

The features are grouped under menu headings.

Menu headings:

Entered by:

General Features

Interface Features

Call Monitor Features

Call Restriction Features

Secure Features

Other Features



To enter a feature from menu heading: \* a digit between 1 and 8\*.

\*See the next pages for an overview. Once the desired feature is displayed: M+ and follow prompts. Many features are simply toggled on/off using the M+ key. Some feature will prompt for further information such as the security code.

To scroll in the menu headings/features: to go forward , to go backward

To return to menu headings: . To exit menu mode: .

## Overview Menu Headings and Features

Key Press:	Menu heading/Feature	Page:
<b>1</b>	<b>General Features</b>	
+ <b>1</b>	Status Review	16
+ <b>2</b>	Automatic Answer	9
+ <b>3</b>	Manual Roaming	14
+ <b>4</b>	Preferred List Display/Change	13
+ <b>5</b>	Auxiliary Alert*	25
*only displayed when used in the carrying cassette		
<b>2</b>	<b>Interface Features</b>	
+ <b>1</b>	Silent Ringer	17
+ <b>2</b>	Silent Keypad	17
+ <b>3</b>	Silent Notepad	17
+ <b>4</b>	Long tone DTMF	18
+ <b>5</b>	PIN Code Enable/Disable	18
+ <b>6</b>	Language Section	19
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+ <b>3</b>	Once Only Audible Timer	19
+ <b>4</b>	Automatic Monitor Displays	21
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+ <b>6</b>	Visual Meters, Display	20
+ <b>7</b>	Rate Programming	20
+ <b>8</b>	Timers/Meters Reset	20
<b>4</b>	<b>Call Restriction Features</b>	
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+ <b>3</b>	Restrict Incoming Calls	21
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+ <b>1</b>	Change/Display Unlock Code	25
+ <b>2</b>	Master Reset	16
+ <b>3</b>	Master Clear	16
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+ <b>1</b>	Display Signal Strength	25
+ <b>2</b>	Battery Meter*	25
+ <b>3</b>	DTX (Battery Save)*	28

\* only displayed when used in the carrying cassette

## Status Review

When you turn the telephone on, the display will show if any features were changed from their default state:

To review the features selected: NON One or more feature(s) selected  
STANDARD

To scroll: to go forward  
 to go backward

If the display shows: STANDARD No default settings have been changed.

To exit status review:

## Master Reset

### USE THIS FEATURE WITH CAUTION!

Using this feature you can reset all of the features back to their default settings.

Which means: Cancellation of:

- Automatic Answer
- Long tone DTMF
- Safety Timer
- All Audible Timers
- Automatic Call Monitor Display
- DTX Operation
- Selected Language (Default: English)
- Auxiliary Alert

Restoring of:

- Ringer
- Notepad Tones
- Light Level to medium
- No restrictions on calls
- Unlocks the telephone
- Volume Levels to medium

To carry out a Master Reset: Security Code

The reset is confirmed in the display by: RESET  
COMPLETE

## Master Clear

### USE THIS FEATURE WITH CAUTION!

Using this feature you perform the same function as Master Reset plus these additional functions:

**Clears:** All 100 short-numbers  
Last number called  
Home Charge Rate  
Roam Charge Rate

**Resets:** Resettable Call Timers  
Resettable Charge Meters

To carry out a Master Clear:

Security Code

When a Master Clear is completed the display shows: CLEAR  
COMPLETE

# INTERFACE FEATURES

The interface features allow you to customize the telephone to meet your needs.

## Silent Ringer

The ring tone heard in connection with incoming calls can be muted.

To enable/disable the ring tone:

to toggle the function on/off

With the ring tone muted an incoming call is only announced by the normal display reading: **CALL**

Note: It is not recommended to use "Silent Ringer" and "Automatic Answer" features at the same time.

## Silent Keypad

Mutes the tone heard when keys are pressed.

To enable/disable the keypad tone:

to toggle the function on/off

## Tone Signalling Features

The tone signalling features allow you to communicate with external devices that respond to DTMF tones.

## Silent Notepad

If you regularly use the Notepad feature which allows you to store a telephone number during conversation, it might be irritating for the other party to listen to the DTMF tones when you press the keys. To avoid this you may enable the silent notepad feature.

To enable/disable the silent notepad:

to toggle the function on/off . When "Silent Notepad" is enabled you will hear a feed-back tone where as the other party will not hear anything. If you want to transmit DTMF tones while "Silent Notepad" is enabled your simply:

enter the digits

## Memory Linking

Memory linking allows you to append a short-number from memory to a number already in the display. jeweils eine Stelle im Display.

To link numbers: enter digits short-number

## Pauses in Memory

This feature allows you to construct and dial sequences of digits separated by pauses. A pause in the number sequence will stop the transmission at that point to allow for a system response, such as a second dial tone. An additional 12 digits may be appended to the standard length of 20 digits for a total of 32 digits. The interantional prefix (+) and pause(s) characters ( ) each represent one digit.

To construct sequences: enter digits   
pause \_\_\_\_\_  
enter digits   
pause \_\_\_\_\_

Note: If you want to recall a short-number instead of entering the digits after a pause has already been inserted: short-number

The sequence may be stored in short-number 1 through 100 like any ordinary telephone number. Short-numbers above 100 (those on your SIM Card) cannot be used to store sequences containing pauses.

*To make a call with a sequence:*

Construct or recall sequence . Digits prior to pause are transmitted.

Await response (dial tone) .

Digits prior to next pause are transmitted. Repeat until all digits have been transmitted.

## DTMF Signalling

DTMF signalling is used, for example, when you want to use the public paging service. See also the section, "Long Tone DTMF".

*DTMF dialling from the keypad:*

1. Place the call and wait for the receiving party to accept data.

2. Enter the digits you want to transmit on the keypad. Each key press transmits the digit as a DTMF tone.

Note: Do not use the key.

*DTMF dialling from short-number memory:*

1. Place the call and wait for the receiving party to accept data.

2. Recall the desired short-number.

3. Repeat 2 and 3, if necessary, until all data have been transmitted.

## Long Tone DTMF

Some electronic equipment such as answering machines may require longer tones. By enabling the long tone DTMF feature the DTMF tone is transmitted as long as you press the key.

*To enable/disable the long tone DTMF:*

to toggle the function on/off.

## PIN Code Enable/Disable

You may enable/disable the PIN Code if your SIM Card allows it. When disabled you do not have to enter the PIN Code when the telephone is turned on.

*To enable/disable the PIN Code:*

PIN Code

The display may show: NOT

ALLOWED

Disabling the PIN Code is not allowed by the service provider.

WRONG  
PIN

The PIN Code was wrong and you must start all over.

BLOCKED

Three unsuccessful attempts of entering the PIN Code have been carried out. See the section, "Unblocking the SIM Card".

## Language Selection

Using this feature it is possible to select the language in which the prompts are to be displayed.

*To select a language:* Scroll to preferred language:

to go forward

to confirm the selection.

to go backward

Turn the phone off and on again for the prompts to be displayed in the selected language.

## Safety Timer

The safety timer prevents the telephone from drawing on the vehicle battery if the telephone has been left on with the engine stopped. As a default the safety timer will turn the telephone off four hours after the ignition is turned off. You may select a different time period between 1 and 999 minutes. The timer is not active when the engine is running.

To select the safety timer feature: .

The display shows the present time period.

To change the time period: new period (up to 999) .

## Adjust Light Level

You may adjust the intensity of display and keypad backlighting to one of four levels:

Off - Low - Medium - High

To select light level . Display reads the present level.

consecutively to change the selection.

## CALL MONITORING

The telephone has a variety of features to help you monitor time and costs accumulated when using the telephone for outgoing calls. Two types of call monitoring features are available: audible and visual. They may be active concurrently.

### One Minute Audible Call Timer

A beep is heard 10 seconds before the end of each minute of a call.

To enable/disable:

.

to toggle the function on/off .

### Programmable Audible Call Timer

A beep is heard 10 seconds before each expiration of a time period (Up to 999 seconds), which you may programme.

To enable/disable: . time period in seconds .

to toggle the function on/off. .

### One Time - Programmable Audible Call Timer

A beep is heard 0 seconds before the first expiration of a time period (Up to 999 seconds) which you may programme.

To enable/disable: . time period in seconds .

to toggle the function on/off. .

## Visual Call Timers and Meters

The visual monitors consist of seven call timers and seven call meters. To utilize the seven call meters you must programme a rate-per-minute into your phone, using charge units or currency. Timers and meters only monitor outgoing calls. Three types of timers and meters are available.

#### *Individual call timers/meters:*

Shows call time and charge for the most recently made call. They are automatically reset before each call. To see time/charge for an ongoing call see the section, "Automatic Monitor Displays".

#### *Resettable call timers/meters:*

Shows call time and charge for the period since you last reset the timers. You will find the following resettable call timers/meters in the telephone:

Home: Shows time and charge for home system since last reset.

Roam: Shows time and charge for other systems since last reset.

Total: Shows the sum of Home and Roam.

To reset all resettable call timers/meters:

#### *Cumulative call timers/meters:*

Shows the total time and charge for the life of the telephone. You will find the following cumulative call timers/meters in the telephone:

Home: Shows time and charge for home system since the telephone was put into service.

Roam: Shows time and charge for other systems since the telephone was put into service.

Total: Shows the sum of Home and Roam.

## To Display Call Timers

Select by scrolling to the desired timer in the list of call timers:

- Individual Call Timer
- Total Resettable Call Timer
- Home Resettable Call Timer
- Roam Resettable Call Timer
- Total Cumulative Call Timer
- Home Cumulative Call Timer
- Roam Cumulative Call Timer

to go forward to go backward

## To Display Call Meters

Displaying meters requires that the telephone is programmed with a home and roam rate. See the section, "Programming of Rates".

Select by scrolling to the desired meter in the list of call meters:

- Individual Call Meter
- Total Resettable Call Meter
- Home Resettable Call Meter
- Roam Resettable Call Meter
- Total Cumulative Call Meter
- Home Cumulative Call Meter
- Roam Cumulative Call Meter

to go forward to go backward

## Programming of Rates

To display call meters, the home and the roam rate must be programmed. The rates can be entered in either currency per minute or charge units per minute.

To programme the rates: Security Code

Home Rate Roam Rate .

Note: The roam rate initially defaults to the home rate to prevent you from setting it to zero by mistake.

## Automatic Monitor Displays

This feature can be used to automatically display the time or charge for an outgoing call during and after each call. *To enable/disable:* .

Select auto timer or auto meter using the scroll keys.

*to confirm the selection* . *to toggle the function on/off* .

## CALL RESTRICTION FEATURES

This feature can be used to activate/not activate a call restriction. The following features are possible:

- Restricted Keypad Dialling
- Restricted Memory Access
- Restricted incoming Calls
- Restricted Phone Number Length

These restrictions can be selected to arrange the telephone correctly.

### Restricted Keypad Dialling

This feature is used to restrict Keypad Dialling except the emergency number "112". Short-numbers can be called, but not be programmed.

*To enable/disable:*

*To toggle the function on/off:* Security-Code

### Restricted Memory Access

With restricted memory access you select a range of short-numbers which should always be accessible for storing and recalling. For the short-numbers outside the range you have the following alternatives:

Protect: Storing and recalling are not allowed.

Recall Only: Only recalling is allowed.

*To enable/disable:* Security Code .

Select "protect" or "recall only" using the scroll keys and then .

Lower limit Higher limit .

### Restricted Incoming Calls

Only outgoing calls are allowed.

*To enable/disable:* .

*To toggle the function on/off:* Security Code

### Restricted Phone Number Length

Among other uses, this feature can be used to prevent international calls. Only phone numbers less than or equal to the selected maximum number of digits may be called.

*To enable/disable:* Security Code .

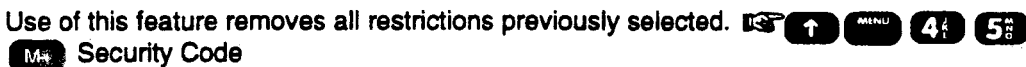
Display shows present maximum.

*To enter new maximum:* New maximum (1 to 20) .

Note: DTMF signalling is disabled. "112" emergency calls are still possible. Digits after pauses in telephone numbers do not count towards length limit.

## Full Service

Use of this feature removes all restrictions previously selected.



**Security Code**

## CALL BARRING

Call barring applies only the SIM Card, not the telephone. By subscribing to call barring, you may bar incoming and/or outgoing calls by entering a special key sequence. The key sequence includes a "barring code" indicating which calls should be barred and a password. The first password is provided by the service provider when you subscribe to the service.

**The most common types of call barring are:**

***All outgoing calls***

**Barring code: 33**

Note: If barring of all outgoing calls is activated, activating other types of outgoing call barring will not make sense.

***All outgoing international calls***

**Barring code: 331**

***All outgoing international calls***

***except those to home service provider***

**Barring code: 332**

***All incoming calls***

**Barring code: 35**

Note: If barring all incoming calls is activated, activating other types of incoming call barring will not make sense.

***All incoming calls when roaming***

**Barring code: 351**

Additional call barring services may be provided. Consult your service provider for further information. Call barring of all incoming calls is used in the following examples. For other types of call barring replace the barring code with the appropriate code for the type in question.

## Activating Call Barring

Barring code Password

*Possible display messages:*

PLEASE  
WAIT                      Your request is being processed.

BARRING  
ON                        Barring has been enabled.

*Example: Barring: All incoming calls (code: 35) Password: 2468*



## Cancelling Call Barring

*To cancel a single type of call barring:* Barring Code Password

*To cancel all types of call barring:* Password

*Display message:*

BARRING  
OFF                      Barring has been disabled.



## Status of Call Barring

If you have forgotten whether call barring has been activated you can check the status of the different types of call barring. Barring Code

*Possible display messages:*

BARRING ON      Call barring activated.

BARRING OFF      Call barring not activated.

*Example:* Check: Barring all incoming calls (code: 35)



## Changing Call Barring Password



Old Password



New Password



New Password



*Possible Display messages:*

PASSWORD CHANGED      Password changing was successful.

MATCHING ERROR      The two entries of the new passwords did not match. Try again.

## Special Call Barring Messages

One more of the following messages may appear when operating call barring. Additional special messages are described in the section, "Special Call Forward Messages."

OUTGOING      You have tried to make a call with barring of outgoing calls enabled.

CALL BARRED

WRONG PASSWORD      Wrong barring password entered. Try again.

CALL BARRED      The number you dialled has barred incoming calls.

## CALL FORWARDING

Call forwarding applies only to the SIM Card, not the telephone. By subscribing to call forwarding, you may forward incoming calls to another telephone number by entering a special key sequence. The key sequence includes a "forwarding code" indicating when an incoming call should be forwarded.

**The most common types of call forwarding:**

**Unconditionally**

Forwards all incoming calls. Note: If Unconditionally call forwarding is activated, activating other types of call forwarding will not make sense.

**Forwarding code: 21**

**No answer**

Forwards calls which you do not answer.

**Forwarding code: 61**

### Not reachable

Forwarding code: 62

Forwards calls which you cannot answer. For example:

- if your telephone is out of coverage,
- if your telephone is switched off
- if your SIM Card is not inserted

### Busy

Forwarding code: 67

Forwards calls received while your phone number is busy. Additional call forwarding services may be provided. Consult your service provider for further information. Call forwarding "on busy" is used in the following examples. For other types of call forwarding replace the forwarding code with the appropriate code for the type in question.

## Activating Call Forwarding

Forwarding code Phone no.

*Possible display messages:*

PLEASE  
WAIT      Your request is being processed.

FORWARD  
ON      Activation was successful. Also displayed each time you place a call if call forwarding is enabled.

INVALID  
NUMBER      The telephone number entered to receive the call is invalid.

Note: You may use different phone numbers for different types of call forwarding.

Example: When: Forwarding, if busy (code: 67) Telephone no. to receive call: 13579246

1 3 5 7 9 2 4 6  
Telephone no.

## Cancelling Call Forwarding

To cancel a single type of call forwarding: Forwarding code

To cancel all types of call forwarding: 0 0 2

Display message: FORWARD  
OFF

Cancellation was successful. Also displayed if the network cancels the call forwarding.

Example:

Cancellation of: Forwarding, if busy (code: 67)

## Status of Call Forwarding

If you have forgotten whether call forwarding is active or to which phone number calls are being forwarded, you can check the status of the different types of call forwarding. Forwarding code








*Possible display messages:*

FORWARD  
ON      Call forwarding activated to the shown phone number.

13579246

FORWARD  
OFF      Call forwarding not activated.

*Example:*

Check: Call forwarding, if busy (code: 67)       

## Special Call Forwarding Messages

One more of the following messages may appear when using call forwarding.

CALL FORWARD	A call placed to you has been forwarded or a phone number you have called has been forwarded.
BUSY	The network is currently processing your earlier request.
TRY LATER	Try again later.
NOT ALLOWED	You cannot activate this service. Possible reasons: Service subscription problems. Incompatible service(s) activated, e.g. Call barring for incoming calls prohibits call forwarding.
NETWORK FAILURE	Communication with the network failed. Try again.
INVALID COMMAND	Failure in key sequence. Try again. May also indicate that the attempt was unsuccessful. If the message appears after repeated attempts consult your service provider.
NOT AVAIL	This service is not available.

## AUXILIARY ALERT

If your installation supports auxiliary alert and the function is enabled, an incoming call will activate an external alerting device (horn/light).

To enable/disable:



to toggle the function on/off



Note: With the external alert enabled you will no turn off the telephone by switching off the vehicle's ignition. Instead the display shows:

ALERT

## DISPLAY SIGNAL STRENGTH

The signal strength is shown as a relative scale, from 1 to 8 segments. A long bar line indicates good conditions for calls.

To display signal strength:



## CHANGING THE UNLOCK CODE

To change the Unlock Code:     

Security Code 

Display shows current Unlock Code.

 New Unlock Code (3 digit) 

## CHANGING THE PIN CODE

The first PIN Code is selected by the SIM card provider. You must enter the PIN Code if prompted by the display before it may be changed.

To change the PIN Code: 0 4 display shows: ENTER OLD PIN

Old PIN Code display shows: ENTER NEW PIN

New PIN Code (4 - 8 digits)

display shows: REPEAT NEW PIN New PIN Code again

If the display shows:

OK the PIN Code has been changed.

MATCHING the two new PIN codes did not match and you must start all over.

ERROR

WRONG If you do not succeed after three attempts the SIM card is blocked. See the section:  
PIN "Unlocking the SIM Card."

Note: If you have forgotten your old PIN Code you may choose a new PIN Code by using the procedure described in the section, UNBLOCKING THE SIM CARD\*.

## UNBLOCKING THE SIM CARD

The SIM card is blocked from use when three unsuccessful attempts to enter the PIN Code have been carried out. To unblock the SIM card again you must choose a new PIN Code by the following the procedure described below. Use the Unblock Code supplied by the SIM card provider.

To unblock the SIM Card: BLOCKED

0 5 Display shows: ENTER UNBLOCK CODE

Unblock Code Display shows: ENTER NEW PIN

New PIN Code (4 - 8 digits) Display shows: REPEAT NEW PIN

New PIN Code again If the display then shows:

OK you have unblocked the SIM card and entered a new PIN Code. If the display shows:

MATCHING the two new PIN codes did not match and you must start all over.  
ERROR

BLOCKED

WRONG your unblock code was wrong and you must start all over.  
CODE

BLOCKED

If you do not succeed after ten attempts the SIM card is permanently blocked.

The display shows: BLOCKED SEE  
SUPPLIER

You must then seek help from your service provider.

## Changing the Security Code



Upon delivery, your security code is "000000"

To change the security code:



Security code

Display shows current security code

 New 6 digit security code 

Write the new security code on your Telephone Data Card. If you do not know the programmed security code, contact your telephone dealer's service center.

# ACCESSORIES AND OPTIONS 3

## CARRYING CASSETTE

### Overview

See figures on rear cover.

Note: Fig. 2 b means "arrow b in figure 2."

- fig. 1 a) Release button  
b) Power connector  
c) Antenna connector
- fig. 2 a) Antenna connector  
b) Cutaway  
c) Transceiver latch  
d) Power connection
- fig. 3 a) Handset connector  
b) Antenna  
c) Shoulder strap clip  
d) Battery  
e) Battery latch  
f) Power on indicator

### Removal from the Vehicle

*Handset:* Always start by making sure that the telephone is switched off. Lift the handset from its mount. Press the lock on the coil cord plug while pulling it out. You are now ready to remove the transceiver.

*Transceiver:* Disconnect the power cable (fig. 1 b) and the antenna cable (fig. 1 c). Press release button (fig. 1 a) while sliding the transceiver toward tray's back wall. Lift the transceiver from the tray.

### Insertion into the carrying cassette

Lower the transceiver into the carrying cassette as shown in fig. 2. The antenna connector (fig. 2 a) will fit into the cutaway (fig. 2 b). Slide the transceiver forward until a click is heard indicating that the unit is locked into place. Connect the handset coil cord to the handset connector (fig. 3 a). Place the handset in the mount. Mount the antenna (fig. 3 b) on the rotating antenna socket. Attach the shoulder strap by sliding the clips (fig. 3 c) into the slots in the carrying cassette. The clips will lock into place. To remove the shoulder strap, press the tabs and lift the clips.

### To Insert the Battery

Slide the battery (fig. 3 d) into the compartment until it locks into place. Arrows on the battery indicate the end to insert first. The + sign on the battery should be facing up.

### To Remove the Battery:

Pull the battery latch up (fig. 3 e). The battery will automatically slide out for easy removal.

### Battery Charging

The carrying cassette uses a rechargeable lead-acid battery. The life of a battery can be greatly affected by the charging method as well as the use.

To maximise battery life:

- Charge new batteries before use
- Avoid discharging the battery completely.
- Charge after extensive use.
- Turn the telephone off while charging
- Charge at or near room temperature
- Avoid overcharging
- Store batteries fully charged

### Overnight Charger

Connect the charger to the power connector (fig. 2 d) on the carrying cassette. Plug the charger into the wall outlet. The overnight charger will take approximately 8 hours to charge a completely discharged battery with the telephone switched off.

### Spare Battery Charger

Remove the battery from the carrying cassette. Connect the charger to the battery contacts. Plug the charger into the wall outlet. The Spare Battery Charger will take approximately 4 hours to charge a completely discharged battery.

### Cigarette Lighter Adaptor

The Cigarette Lighter Adaptor supplies power to the carrying cassette from the vehicle's electrical system. For this reason it is advisable to use the adaptor only when the engine is running. Connect the charger to the power connector (fig. 2 d) on the carrying cassette. Plug the Adaptor into the cigarette lighter. Charging time depends on the vehicle's electrical system and the usage while charging. The adaptor has a 10 Amp. fuse which you may replace yourself, if necessary.

### Mains Operation

For fixed applications an alternative power source to the battery is the main power supply. Remove the battery and connect the power supply to the power connector (fig. 2 d) on the carrying cassette. Plug the power supply into the wall outlet.

### Operation in the Carrying Cassette

#### Keypad and Display Lighting







To conserve battery power, the keypad and display lighting will turn off after a few seconds. Pressing any key will turn off after a few seconds. Pressing any key will turn the lighting back on.

#### Hands Free Operation

Hands Free operation may also be used when the telephone is placed in the carrying cassette. The operation is carried out as described in the telephone user guide. When operating in Hands Free mode, you will hear the call through the loudspeaker built into the carrying cassette. Direct your conversation towards the microphone built into the handle.

### Battery Meter

The battery meter is shown as a relative scale, from 1 to 8 segments. A long bar line indicate a long remaining operating time. When the battery needs to be charged a warning tone is heard and the display shows: **LOW BATTERY** When the battery strength drops the lowest level for normal function, the telephone is switched off automatically.

To display the battery meter:      

Note: If powered via the Cigarette Lighter Adapter, the display shows: **AUX POWER**  
instead of the bar line.

### Power Saving Feature (DTX)

The Power Saving Feature, also known as Discontinuous Transmission, allows the telephone to operate at reduced power when conversation is not taking place.

To enable/disable the DTX feature:      

  to toggle the function on/off.

### Use Inside a Vehicle

**With vehicle installation:** Remove the handset and transceiver from the carrying cassette and reinstall in the vehicle. To remove, reverse the earlier instruction for assembly. To remove transceiver - release transceiver latch (fig. 2 c).

**Without vehicle installation:** Secure the telephone by firmly attaching the seat belt through the carrying cassette's handle. The cigarette lighter adaptor will supply power from the vehicle's electrical system, saving the carrying cassette battery for use away from the vehicle.

To provide better reception during in-vehicle use, remove the carrying cassette antenna and connect the cable from an external antenna to the antenna connector.

### General Safety Information

The equipment may become warm during normal operation. No part of the human body should come within 20 centimeters of the antenna during use of the telephone.

The telephone must be switched off:

- near electrical blasting caps
- in an explosive atmosphere
- in aircrafts
- in hospitals
- when warning signs prohibit use of cellular telephones.

**Note:** It is not enough to leave the telephone in stand by mode, as the telephone will automatically transmit to acknowledge an incoming call.

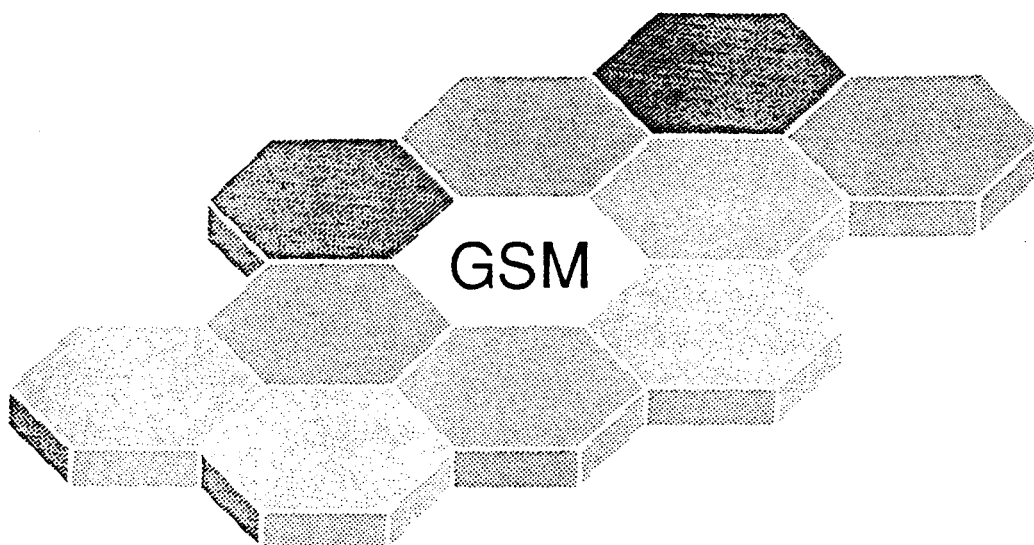
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# **A TECHNICAL OVERVIEW**

## 3.1 Overview of Current Cellular Systems

### 3.1.1 What is a Cellular Telephone System?

A cellular telephone system links subscribers in the public telephone system to a cellular subscriber by means of a two-way radio link. Because the link is made via radio, the limitations of a fixed wiring are removed.

This enables the mobile subscriber to move around, either on foot or in a vehicle of any type, both making and receiving calls. This is obviously conditional upon the mobile subscriber being within range of a suitable base station or stations for the duration of the call.

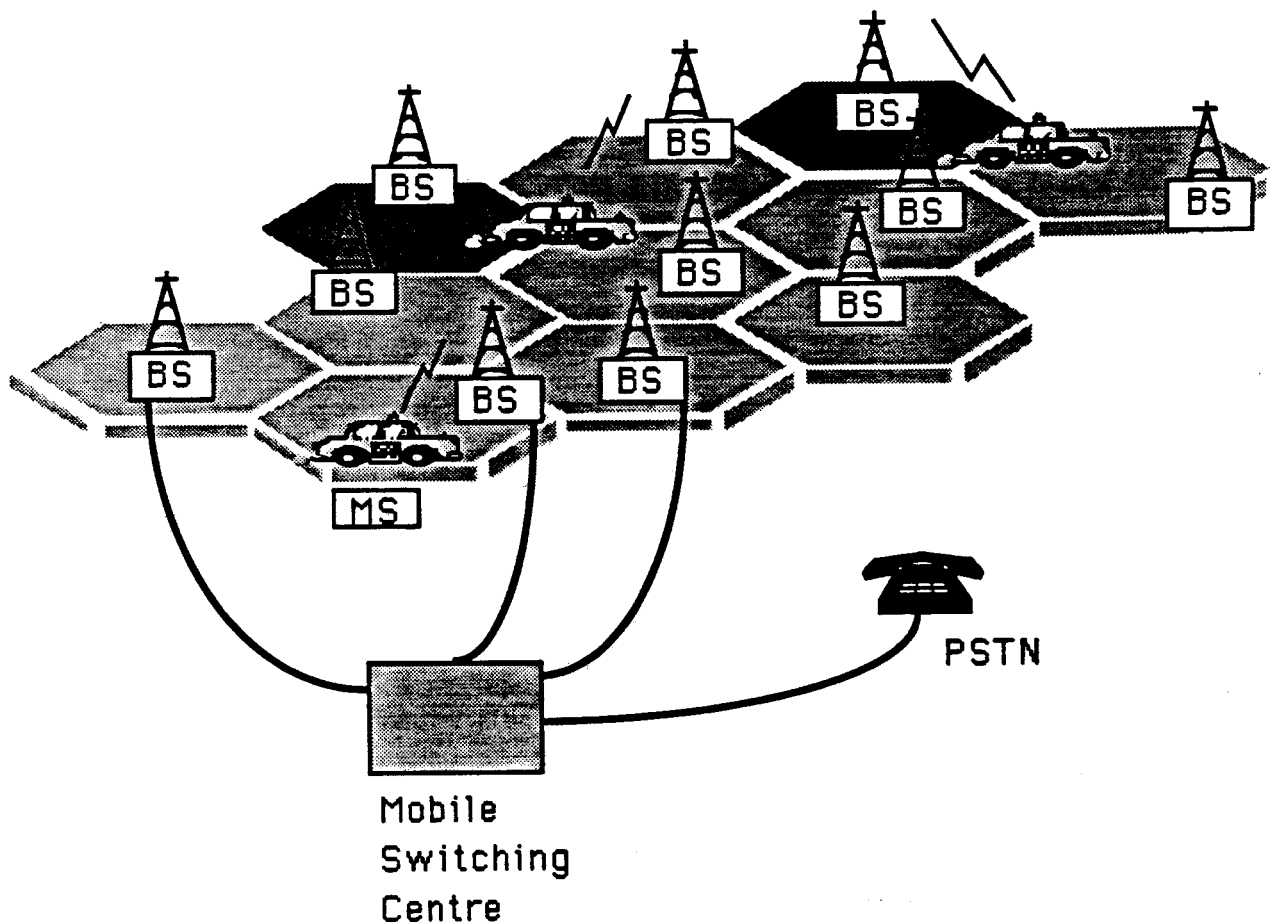
Cellular phones come in three basic forms - 'mobiles', 'transportables', and 'handheld portables'.

The mobile is designed for in-vehicle mounting, whilst the transportable is usually a mobile in a carry case with built-in battery. The handheld unit is usually a lower power device, thus providing reduced usability in fringe coverage areas. i.e. those areas a long way from the nearest base station.

The main components which make up a cellular system are depicted in Fig. 3.1.1 below.

Fig 3.1.1

**BASIC CELLULAR SYSTEM**



### 3.1.2 Why CELLULAR ?

The main attractions of "cellular" systems centre around their ability to cater for a wide range of traffic loading, and their ability to handle more customers than the earlier non-cellular systems.

The systems are known as "cellular" systems because the basic principle of the design is to split the required coverage area into "cells". These fit together to provide unbroken coverage in the required geographical area.

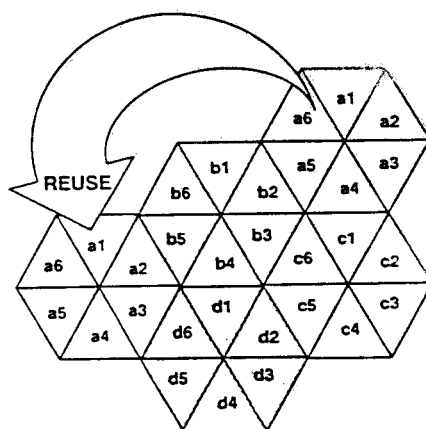
From the previous diagram it will be seen that the cells are conventionally regarded as being hexagonal, but in reality they are irregularly shaped because of interference of hills, tall buildings, antenna radiation patterns and numerous other factors.

The radio frequencies in one cell can only be reused in another cell that is geographically separated so that the two will not cause undue interference with each other. This can be described mathematically as a frequency reuse pattern. There are several theoretical patterns, and the exact method used depends upon the coverage area and the density of channels required to serve it.

In rural, low-usage areas large cells are constructed. These can be as big as 30 km in diameter. In highly dense areas of usage, such as city centres, the diameter of the cells reduces to around 0.5 to 1 km so that the frequencies can be reused more often. To further improve frequency reuse, cells can be "sectorised" - i.e. each cell is subdivided into 60° or 120° sectors, each of which has its own radio channels allocated. This is usually done only in heavily used areas. A diagrammatic form of this frequency reuse pattern is shown in fig 3.1.2.

Fig. 3.1.2

#### FOUR CELL PATTERN



60 degree sectors

### 3.1.3 The Cellular Frequency Spectrum

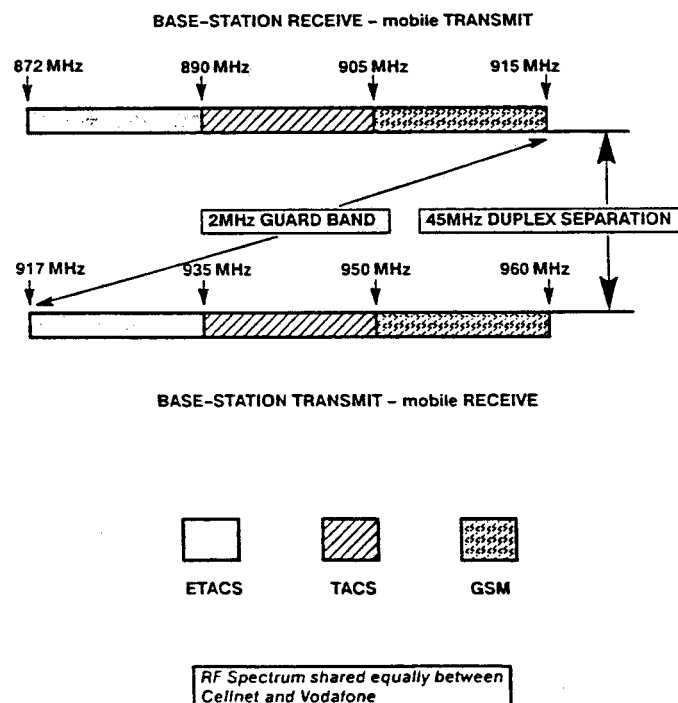
Each cellular "channel" is, in fact, a combination of two RF frequencies, one allocated to the "up-link" (mobile transmitted signals to the base station) and the "down-link" (base station transmitted signals to the mobile). Two radio frequencies are required so that simultaneous two-way conversation and signalling is possible. This is known as "duplex" transmission.

The frequencies used for this bi-directional communication have a fixed relationship to each other. both ETACS and NMT have the mobile's transmit frequency 45 Mhz lower than that of the base station, and each TX-RX pair is assigned a channel number. Eg. in the ETACS system, a mobile set to channel 252 will be transmitting on 876.2875 Mhz, and will be receiving from the base site on 941.2875 Mhz.

An overview of the radio spectrum for ETACS is shown below in Fig. 3.1.3

Fig. 3.1.3

#### RADIO FREQUENCY SPECTRUM



### **3.1.4 Switching and Control**

Having established radio coverage through the use of cells based on a specific reuse pattern appropriate to the density of expected use, the control of calls can be considered, perhaps when the mobile is in motion.

At some point, the mobile will reach the boundary of its serving cell (i.e. the one through which the call is currently in progress). The signal strength of the radio channel will be falling, and the noise and interference will be increasing. When the predetermined threshold values of certain parameters have been reached, the system will look for a neighbouring cell that is closer to the mobile (determined by the neighbouring cells "listening" to the mobile in question and reporting signal strength back to the control system).

To perform a handover, the system has to be capable of telling the mobile to retune to a new channel in the new cell. It has to switch the conversation from the old cell to the new one without breaking call continuity for longer than is absolutely necessary. In the ETACS system this is around 300 ms, but is significantly longer and more obtrusive in the NMT system.

Consequently, at the heart of all cellular networks lies a switching and control system which provides all the functions described above. It switches calls from mobile to mobile, and calls to and from the PSTN. It will usually co-ordinate handovers, allocate radio channels, validate subscribers and compile billing records.

### **3.1.5 Cellular across Europe**

There are approximately nine different cellular systems across Europe, with the main ones being NMT450, NMT900, and ETACS. Even systems with identical technical specifications are not designed to interwork to any great extent, other than passing calls between them. For example, it is not possible to make calls from Italy (ETACS) with a telephone registered in the UK (also ETACS). A notable exception is the NMT system in Scandinavia, where inter-country "roaming" is in full operation.

Generally, this has not been possible throughout the rest of Europe. However, with co-operation and harmonisation in every other field, the need for a common mobile telephone standard was becoming ever greater.

An executive body known as Groupe Speciale Mobile (GSM) was set up in 1982 to coordinate the complex task of developing the specifications required for such a system.

GSM has become the widely accepted name for the new mobile telephone system standard to be adopted throughout Europe.

## 3.2 Why GSM ?

### 3.2.1 Technology Limitations

Present, non-GSM cellular telephone systems use an analogue air interface. This uses a radio modulation technique similar to that used by everyday FM (frequency Modulation) commercial broadcasting. This technology is tried and tested and generally works very well - but it does suffer from a few problems, particularly in areas where demand is very heavy, such as the centre of a large city. So-called 'second generation' GSM systems address these problems by using a digital air interface. This also enables these systems to offer a wider range of subscriber services. The first all-digital systems will be entering service within the next few months, and are anticipated to provide a much more consistent, high quality telephone service than has been possible with the older analogue technology.

### 3.2.2 GSM - The Driving Forces

- \* **Digital Air Interface** - The GSM phone will provide entirely digital link between the telephone and the base station, which is, in turn, linked digitally into the switching subsystems and on into the PSTN.
- \* **ISDN Compatibility** - ISDN is a digital communications standard that many countries are committed to implementing. It is designed to carry digital voice and data over existing copper telephone cables. The GSM phone will be able to offer very similar features to the ISDN telephone.
- \* **Open Interfaces (C7, X.25 etc)** - The use of standard CCITT protocols and interfaces means that system planners can select different pieces of hardware from different manufacturers with assurance that they will be compatible.
- \* **Security and Confidentiality** - Telephone calls on analogue systems can very easily be overheard by the use of a suitable radio receiver. GSM offers vastly improved confidentiality because of the way in which data is digitally encrypted prior to transmission.
- \* **Better Call Quality** - Co-channel interference, handover breaks, and fading will be much more swiftly handled in the digital system. The mobile itself carries out signal strength measurements on up to six adjacent cells, and the quality of the traffic channel is measured by both the mobile and the base station. The handover criterion can thus be much more accurately determined and made before the channel deteriorates to the point that the subscriber notices.
- \* **Efficiency** - The GSM system uses resources in a much more efficient way than the analogue systems.



### **3.2.3 TELESERVICES**

This is the collective term used to list the services available to the subscriber. These include Telephony, Emergency calls, Short message, Videotex Access, Teletex, Group 3 Fax, and may other data services.

1. A single RF carrier at the base site can support up to eight mobiles by use of TDMA (Time Division Multiple Access). When the half rate CODEC is introduced this will increase to 16 conversations.
2. The system has high resistance to co-channel interference. This means that a much tighter frequency reuse pattern can be tolerated, leading to more efficient use of the RF spectrum.
3. The system carries out periodic location updates of mobiles. It uses an "Attach/Detach" procedure so that it knows whether a mobile is active, and does not waste time paging mobiles that are switched off, or paging a wide area, because the location is accurately known.

### 3.3 Scope of the GSM Recommendations

The criteria forming the basis of the GSM system design are as follows:

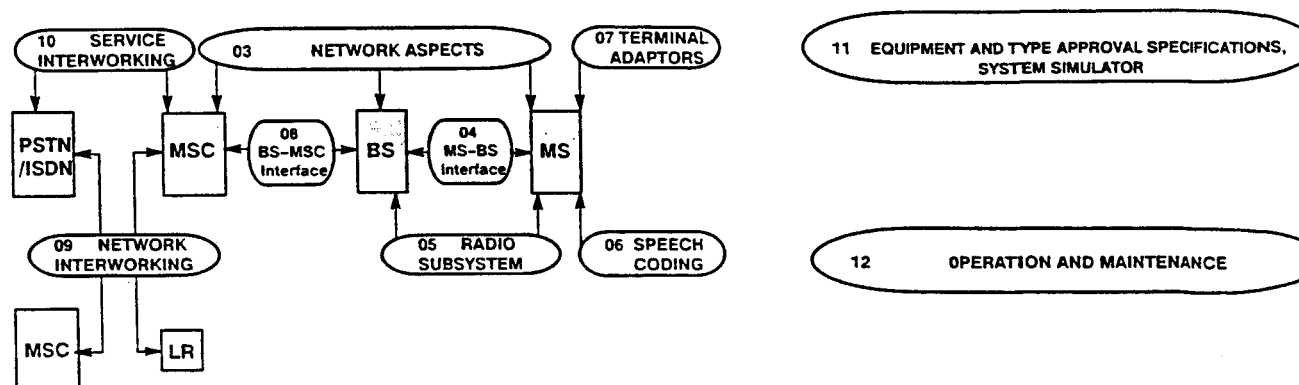
- Spectrum efficiency
- Subjective voice quality
- Mobile cost and portability
- Base-station costs
- Ability to support new services
- Ability to co-exist with existing systems

The recommendations and their associated notes run to around 130 documents, some of which are several hundred pages long ! They are divided into several sets of recommendations, each providing a detailed description of a different aspect of the system. The recommendations are numbered from 00 to 12, and are as follows:

- 00 Preamble
- 01 General
- 02 Service aspects
- 03 Network aspects
- 04 MS-BS interface and protocols
- 05 Physical layer in the radio path
- 06 Audio aspects
- 07 Terminal adapters for mobile stations
- 08 BTS/BSC and BSC/MSC interfaces.
- 09 Network interworking
- 10 Service Interworking
- 11 Equipment specification and type approval specification
- 12 Network management

For the purpose of this brief overview, the technical description will be based on the MS-BS Interface recommendations (part 04).

#### SCOPE OF GSM RECOMMENDATIONS



### 3.4 Classes of Mobile Station

As with existing cellular systems, there are different categories of mobile stations, based on their physical size. These can vary from vehicle-mounted mobiles, through transportable systems down to the smallest handheld portables. They are divided into four classes, as shown in Table 3.4.1

Power Class	Peak TX Power (Watts)
1	20
2	8
3	5
4	2

Table 3.4.1

## **3.5 Technical Overview of Mobile/Base Station Interface**

### **3.5.1 Introduction**

The GSM system is designed to operate over the frequency band 890-915 Mhz (for the mobile station transmit) and 935-960 Mhz for the base station transmit band. The resultant 45 Mhz duplex spacing is therefore compatible with the existing ETACS and NMT systems. Figure 3.1.3 on page XX gives a graphical description of the frequency bands to be used. At present, part of the TACS band uses these frequencies, but the long-term plan is to transfer allocation gradually from TACS to GSM as the system expands.

As already discussed, the GSM system uses a completely digital air interface. This has several advantages over analogue systems currently in use:

- \* It is 'noise-robust' - enabling tighter frequency reuse patterns
- \* It incorporates error correction, protecting corruption of speech and data
- \* It offers greatly enhanced privacy and security to users and system operators
- \* The system is ISDN-compatible.

### **3.5.2 What is a digital air interface ?**

With analogue Frequency Modulation the instantaneous carrier frequency is directly proportional to the analogue signal that is being conveyed over the air.

The digital system converts all the information that is to be transmitted (i.e. speech, signalling, data etc) into a sequence of binary digits. This includes a numeric representation of the speech. The carrier frequency is modulated by the digital signal, which is a stream of 1's and 0's. The carrier frequency is modulated using a technique known as Gaussian Minimum Shift Keying (GMSK). The actual mechanics of this method are beyond the scope of this brief overview. However, this method of modulation is used due to its bandwidth economy. Its transmission efficiency is around 1.7 bits per Hertz of RF spectrum.

### 3.5.3 The GSM Physical Channel

It was briefly mentioned earlier that a single GSM RF carrier can support up to eight mobile subscribers simultaneously. Figure 3.5.3 shows how this is accomplished. In simple terms, each channel occupies the carrier for one eighth of the time. This technique is known as Time Division Multiple Access (TDMA).

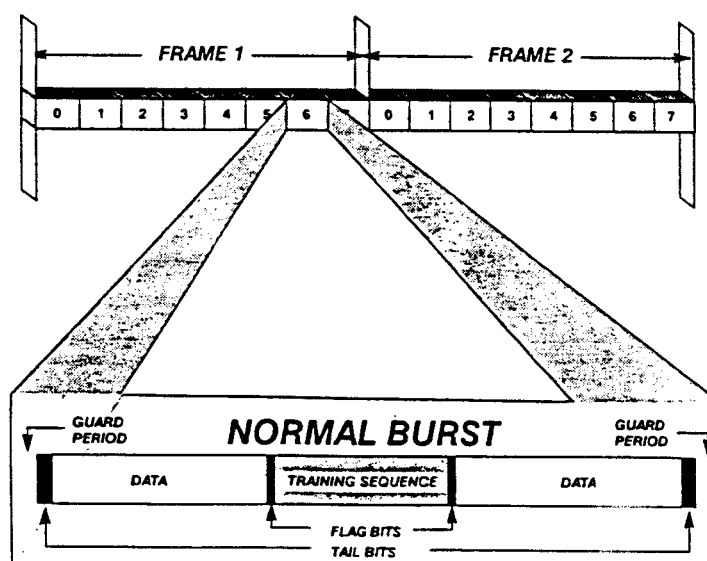
Real time, represented by the horizontal axis of the diagram, is divided into discrete periods known as time-slots. As eight channels share the same carrier, the time slots are arranged in sequence and are numbered 0 to 7. Each repetition of the sequence is known as a TDMA frame. Each channel is allocated a timeslot within the frame until the call is terminated or a handover occurs. The TDMA frames are then built into further frame structures according to the type of channel.

For such a system to work, the timing of the transmissions is obviously of critical importance. If the timing is inaccurate, then the base station cannot determine how the incoming data relates to the individual channels. The diagram represents exact periods of time, and for the system to work, a mobile or base station (BTS) must transmit or receive its 'data burst' within the time slot allocated to it.

Each data burst, occupying its allocated time slot within successive TDMA frames provides a single GSM physical channel carrying a varying number of logical channels between the mobile and the base station. The exact number and type of these logical channels depends upon the nature of the activity in progress.

Fig. 3.5.3

#### TIME SLOTS AND TDMA FRAMES



### **3.5.4 GSM Logical Channels**

These break down into two main groups

- \* Traffic Channels
- \* Control Channels

#### **3.5.4.1 Traffic Channels**

The traffic channel acronym is TCH, and there are various types, as detailed below:

##### **Full Rate:**

- \* TCH/FS : Speech (13 kbit/s net, 22.8 kbit/s gross)
- \* TCH/F9.6 9600 bps - Data
- \* TCH/F4.8 4800 bps - Data
- \* TCH/F2.4 2400 bps - Data

##### **Half Rate (Future)**

- \* TCH/HS Speech (6.5 kbit/s, 11.4 kbit/s gross)
- \* TCH/H4.8 4800 bps - Data
- \* TCH/H2.4 2400 bps - Data

Each traffic channel of what ever type always has an associated control channel, (ACCH), which can be either Fast (FACCH) or Slow (SACCH).

#### **3.5.4.2 Control Channels**

The GSM recommendations specify several types of control channel (CCH):

- \* Broadcast (BCCH)
- \* Common (CCCH)
- \* Dedicated (DCCH)

**3.5.4.2.1 The Broadcast Control Channels** are one-way channels, carrying information about the network, system parameters, parent cell and adjacent cells. It is transmitted continuously, and its signal strength is measured by the mobiles to determine where a handoff should go to. It is always transmitted on a designated carrier, (the BCCH Carrier) in Time Slot 0. When there is BCCH traffic, dummy bursts are inserted to ensure a continuous data stream.

Also included on BCCH are what are known as synchronising channels (SCH) to provide the mobile with frame synchronisation. This ensures that the burst timing occurs when the Base Station requires. There is also a Frequency Control Channel (FCCH), which provides data for carrier frequency synchronisation.

**3.5.4.2.2 Common Control Channels** are bi-directional, and are used in both directions for call set-up (outgoing and incoming):

- \* Random Access Control Channel (RACCH) is the 'up-link' used by the mobile to signal to the base station in response to an origination or a page.
- \* Paging Channel (PCH) and Access Grant Control Channel (AGCH) are the 'downlinks' from the base station to the mobile.

When a mobile is switched on, it is continuously monitoring both the PCH and the AGCH.

**3.5.4.2.3 Dedicated Control Channels (DCCH)** are assigned to a single mobile connection for call set-up, or for measurement and handover purposes. DCCH comprises

- \* Standalone Dedicated Control Channel (SDCCH), which supports the transfer of data to and from the mobile during call set-up. Like a Traffic Channel, it has its own Slow Associated Control Channel, and is released once call set-up is complete.
- \* Associated Control Channel (ACCH). This can be associated with either a Traffic Channel or a SDCCH, and is used for measurement and handover purposes. The Slow Associated Control Channel (SACCH) in the downlink direction contains power control and timing information, and in the uplink direction RSSI and link quality reports are sent to the base station from the mobile. The Fast Associated Control Channel (FACCH) is associated only with traffic channels, and transfers 'event' information such as that required to initiate a handover. It 'steals' bursts from the traffic channel to gain access to the physical channel. Due to the high degree of error correction the traffic data lost is not noticeable.

### 3.5.4.3. SUMMARY OF CONTROL CHANNEL STRUCTURE

A complete structure of the Control Channel subsystem is given in Figure 3.5.4.2.

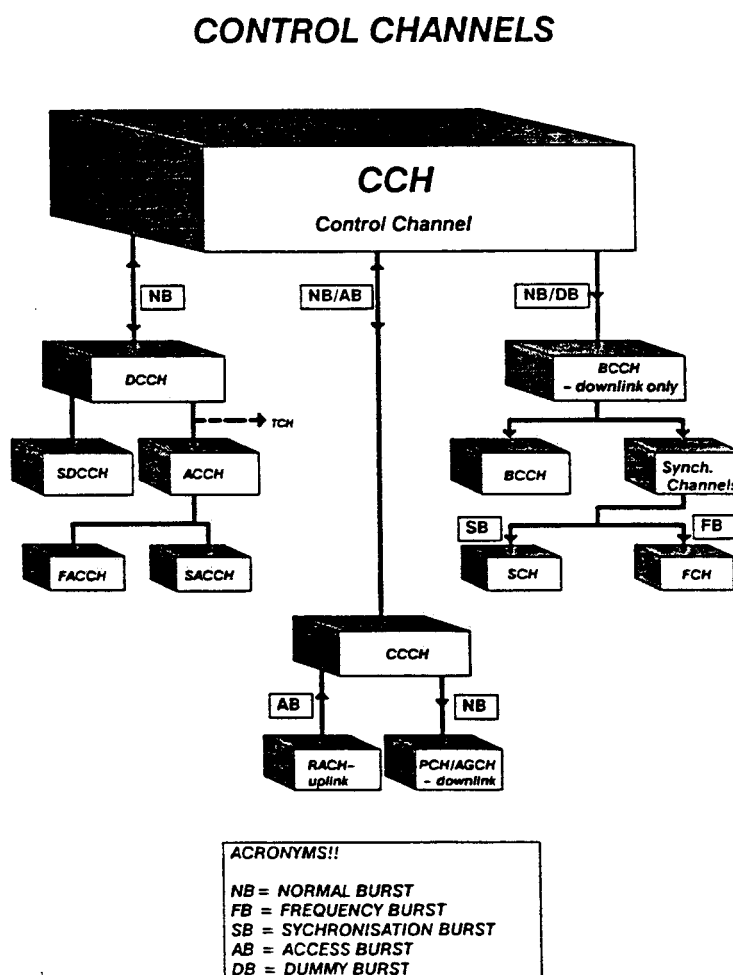
As a mobile makes or receives a call, the succession of events is from left to right across the diagram.

Making a call, the mobile would access the system using RACH, having previously used BCCH to synchronise with the Base station timing and frequency, and to obtain information about its serving cell and the surrounding cells. AGCH would then direct the mobile to a SDCCH which would be used for the remainder of the call set-up process. This complete, the mobile is instructed to move to SACCH for the remainder of the call. The conversation would at this point be taking place on the TCH. A handover would be initiated using FACCH.

When receiving a call, PGCH alerts the mobile which responds via RACH. AGCH then directs the mobile to an SDCCH, at which point the remainder of the process is similar to above.

It will be seen from the diagram that there are various types of burst that are used in different circumstances.

FIGURE 3.5.4.2





### 3.5.5 Timing Advance and Power Control

To simplify the design of the mobile, the GSM recommendations specify there be an offset of three timeslots between the mobile's transmit and receive period. This avoids the need for the mobile to transmit and receive simultaneously. Figure 3.5.5 illustrates this.

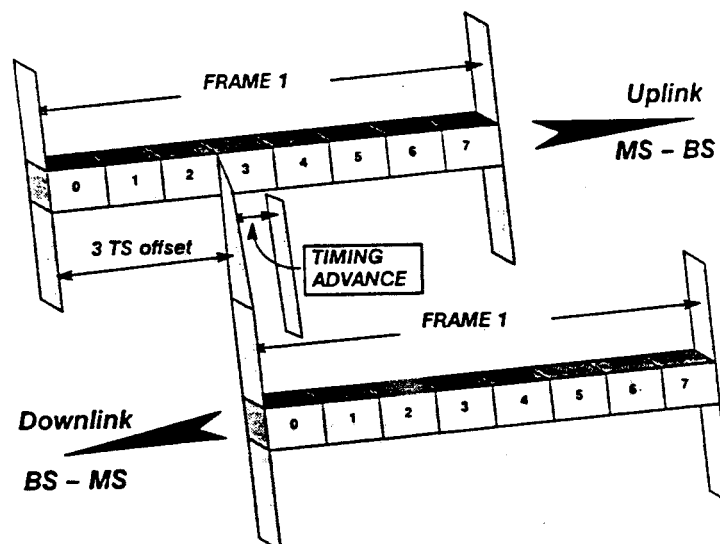
As described earlier, the synchronisation of the TDMA system is critical because bursts have to be transmitted and received within the real time slots allotted to them. The further the mobile is from the base station, the longer it will take for the burst to travel between them. The GSM base station compensates for this by asking the mobile to transmit earlier as the mobile gets further away.

This timing advance is superimposed on the three time slot nominal offset as shown.

Power control is an optional feature in GSM that is already used to great effect on the analogue systems. The system controls both the mobile and the base station transmitter power, thus ensuring that co-channel and adjacent channel interference is kept to a minimum.

Figure 3.5.5

#### ***TIMING ADVANCE***



### 3.5.6 Multipath Fading

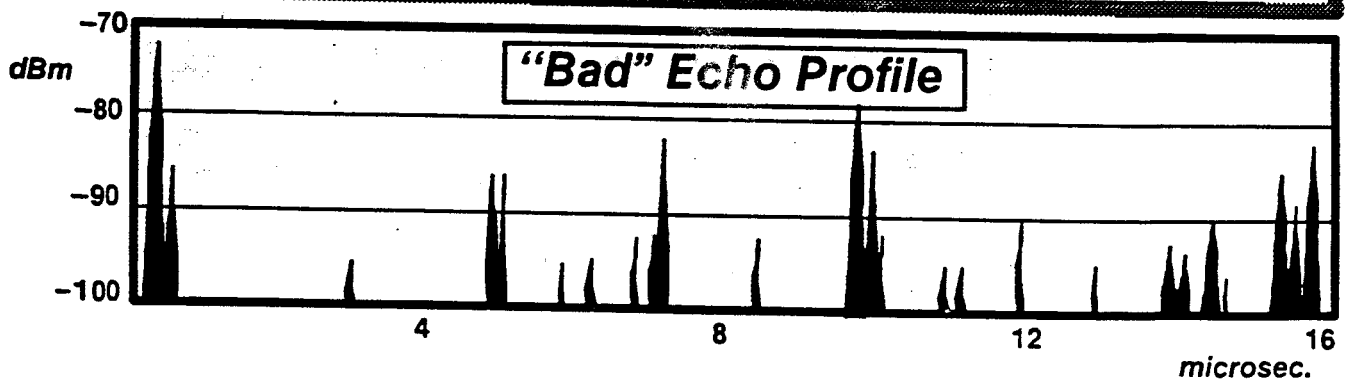
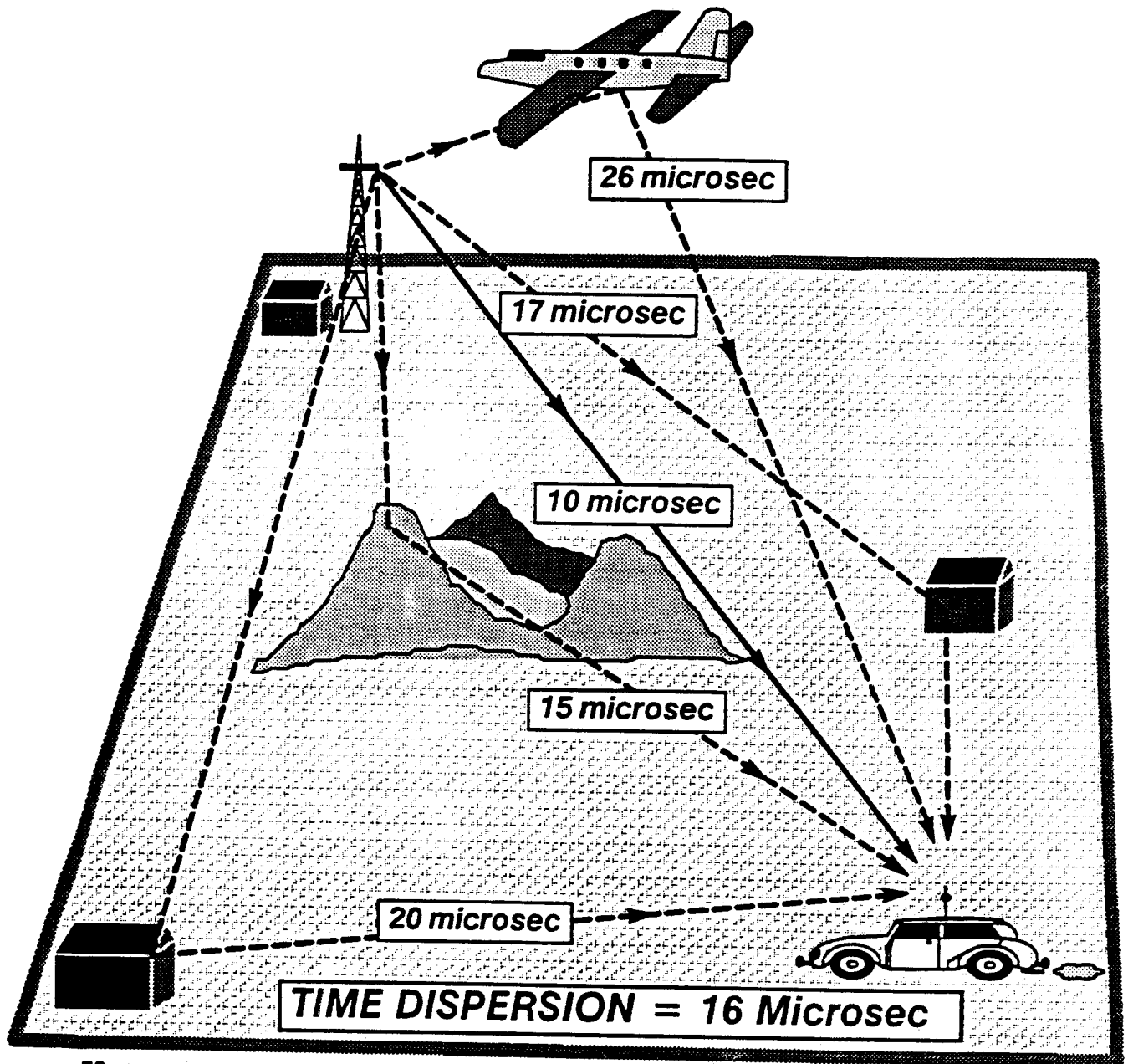
Multipath fading is an effect which arises as a result of a transmitted signal arriving at the receiver via two or more routes. These are usually due to reflections caused by buildings, vehicles, geographical features (i.e. hills, mountains!). Atmospheric conditions can contribute to such problems because of the way in which varying humidity and temperature affects radio propagation. As a result of these reflections, the same signal (or bits of the same signal) will all arrive at the receiver at different times. This is known as time dispersion. At the receiver, the signals will either interfere constructively (adding together) or destructively (cancelling each other out). If they destructively interfere the wanted signal may not be intelligible at all. This effect can easily be noticed on distant medium wave radio stations at night due to reflections from the earth's atmosphere arriving at the receiver at later than the ground wave.

The illustration in Figure 3.5.6 shows a few routes by which a pulse of radio energy might propagate from the base station to the mobile (and vice versa). The direct path from the base station in this example takes 10 micro seconds, with reflected signals arriving at the receiver between 15 and 26 microseconds later. The total time dispersion of the impulse is thus 16 micro secondss. A typical urban environment would have time dispersion of up to 5micro seconds.

GSM employs three methods to counteract this effect:

1. **Frequency Hopping.** Each time the mobile or base station transmits a burst, it transmits it on a different RF carrier. A pattern is defined using a frequency hopping table.
2. **Equalisation.** Both the base station and the mobile station receivers contain an Equaliser that compensates for the phase and amplitude non-linearity of the path between them. This is usually termed the channel impulse response. The equaliser uses the mid-burst training sequence (see fig.3.5.3), also known as "mid-amble", to estimate this response, and uses an active digital filter to construct an inverse response. This goes a long way to cancelling the non-linearity of the physical path, and overcomes the worst effects of multipath fading.
3. **Error Correction.** After both frequency hopping and equalisation have been used, some errors will inevitably occur. The data sent over the digital channel is therefore packed with extra information such that lost data can be satisfactorily recovered.

# MULTIPATH FADING



### **3.5.7 Speech Encoding**

Ordinary speech is made up of a continuously varying pattern of sound waves, which is converted by the microphone into an 'analogue' electrical signal. i.e. an electrical signal that can take an infinite set of values.

Most modern telephone systems turn this analogue signal into a digital form for easy transmission and switching. In order to represent the speech faithfully from 300 Hz up to 3.4 kHz (normal telephone channel bandwidth) a speech sampling rate of 8 kHz is used. i.e. the instantaneous value of the speech is sampled 8000 times a second. Each sample is represented by an 8-bit binary number, giving 28 possible levels. The resultant data output of this speech digitisation process is 64 kbits per second. This has been adopted as a standard for digital speech telephony.

However, if this amount of data were to be transmitted over a radio channel it would be very uneconomical in bandwidth. GSM therefore specifies that this digitised speech should be condensed to a lower bit rate of 13 kbit/sec by means of a speech codec. This device takes in the standard 64 kbit/s digitised speech by means of the following processes:

- \* LPC - Linear Predictive Coding
- \* LTP - Long Term Prediction
- \* RPE - Residual Pulse Excitation

The actual mechanics of the Codec are beyond the scope of this document.

The codec in fact does not produce a continuous bit stream, but sends out the data in 20 ms bursts of 260 bits each. This 20 ms block of data is expanded using a complex error correction system, to a total of 456 bits. The required data rate to transmit the speech over the air interface has now increased to 22.8 kbit/s.

### 3.5.8 Interleaving

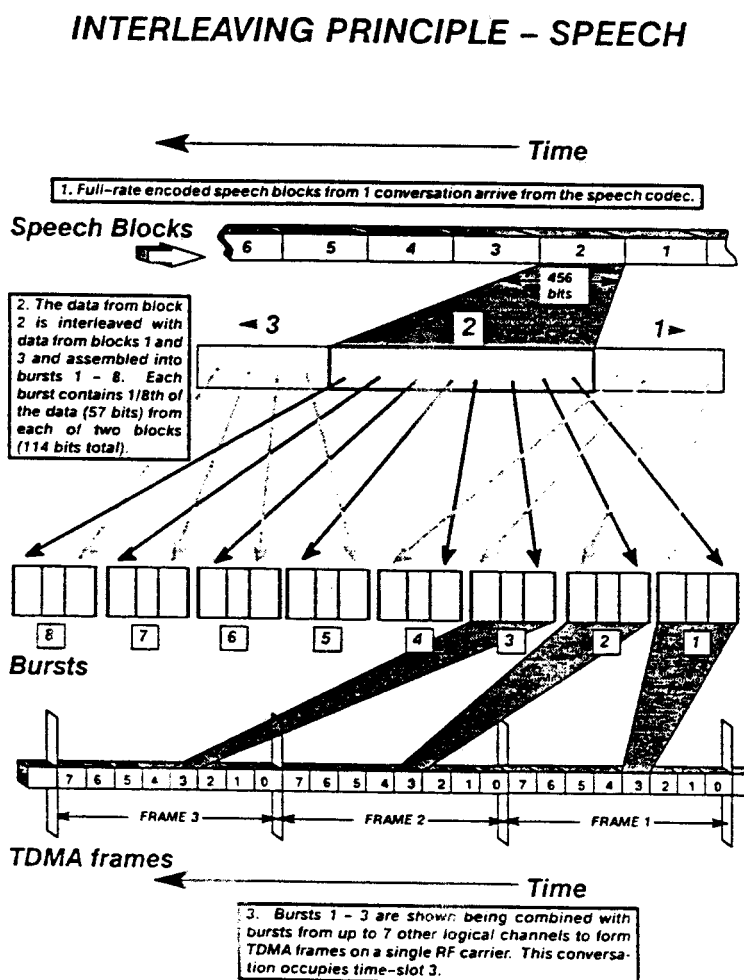
Since most interference is random, if a sudden burst of interference occurs, it is likely to completely corrupt all data over a period of time. In order to combat this, GSM carries out a process known as interleaving. This takes each data block (456 bits, and spreads the bits out over a eight consecutive bursts. Fig. 3.5.8 illustrates the complete process from the 456-bit speech blocks to the bursts that are actually sent over the air in each TDMA time slot.

The result of this process is that if one burst gets corrupted, only an eighth of the data in each speech block is destroyed. Using the built-in forward error correction in the speech blocks, the original data can be satisfactorily reconstructed.

Interleaving the speech information obviously spreads the speech data out over a finite time period. This causes a slight delay between what the person says, and its arrival at the distant telephone subscriber. The actual delay imposed is around 90 ms. At some point between the GSM base station and the PSTN, an echo canceller is interposed to remove any echo from the PSTN 4-2 wire hybrid connection.

Data transfer is accomplished in a similar manner, except that since propagation delay is less important than accuracy, the data is interleaved across 16 bursts. This improves the reliability of data even more.

Fig. 3.5.8



### 3.6 MAPPING LOGICAL CHANNELS ONTO THE TDMA FRAME STRUCTURE ...

So far, we have discussed the various logical channels, each of which is designed to be transmitted in an appropriate manner. These channels are fitted into a larger data structure, known as "*FRAMES*". The following section looks in more detail at the overall data structure of the GSM system. It is by no means comprehensive, but its inclusion in a manual of this type is to give a more detailed picture of the GSM system.

#### 3.6.1 BURSTS

The diagram figure 3.5.3 , reminds us of the general form of a GSM burst.

The receiver can only receive the burst and decode it if it is received within the time-slot designated for it. The timing, therefore, must be extremely accurate, but the structure does allow for a small margin of error by incorporating a 'guard period' as shown in the diagram. To be precise, the time-slot is 0.577ms long, whereas the burst is slightly shorter at 0.546ms. Eight bursts occupy one TDMA frame.

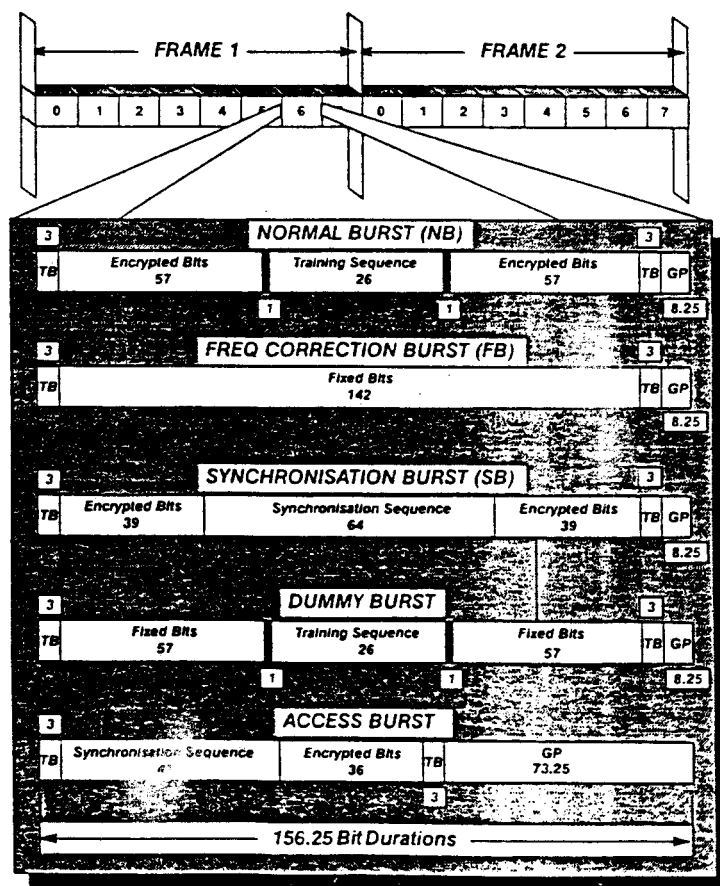
The "*flag-bits*" are set when the frame has been 'stolen' by FACCH (the Fast Associated Control Channel) and the "*training sequence*" is used by the receiver's equaliser as it estimates the transfer characteristic of the physical path between the base-station and the mobile.

Figure 3.6.1. shows the five types of burst employed in the GSM air-interface and shows that all bursts, of whatever type, have to be timed so that they are received within the appropriate time-slot of the TDMA frame. The "burst" is the sequence of bits transmitted by the base-station or mobile - the "time-slot" is the discrete period of real time within which it must arrive in order to be correctly decoded by the receiver.

1. **Normal Burst.** The normal burst carries traffic channels and all types of control channels not mentioned above. Bidirectional.
2. **Frequency Correction Burst.** This burst carries FCCH downlink to correct the frequency of the mobile's local oscillator, effectively locking it to that of the base-station.
3. **Synchronisation Burst.** So called because its function is to carry SCH downlink, synchronising the timing of the mobile to that of the base-station.
4. **Dummy Burst.** Used when there is no information to be carried on BCCH (therefore it is transmitted in time-slot 0 of the BCCH carrier).
5. **Access Burst.** This burst is of much shorter duration than the other types. The increased guard period is necessary because the timing of its transmission is unknown - this is due to the unknown quantity of the mobile's location and the lack of timing advance information at this point during the call set-up process.

Figure 3.6.1.

### GSM BURST TYPES



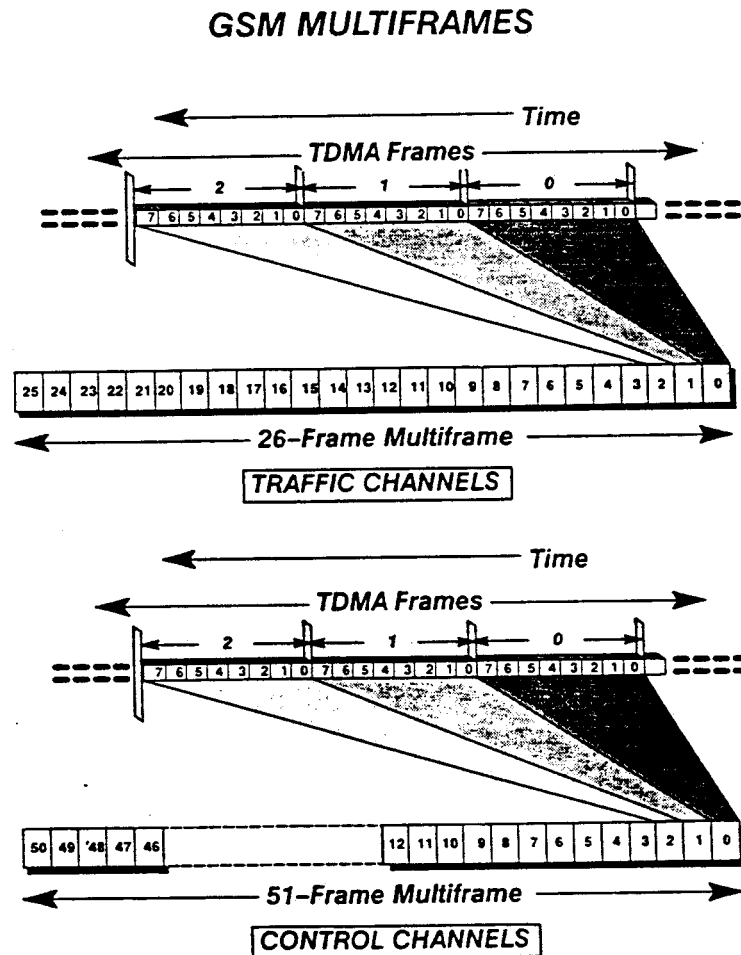
### 3.6.2. MULTIFRAMES AND TIMING

So far we have discussed the way in which the logical channels are encoded, interleaved and then transmitted as a succession of bursts within a TDMA frame structure. There are eight time-slots within each TDMA frame, enabling eight physical channels (OSI 'layer 1') to share a single physical resource - the RF carrier. In turn, each physical channel may be shared by a number of logical control or traffic channels as we have seen.

In order to understand how a single physical channel is shared by various logical channels, it is necessary to introduce the GSM *multiframe* structures that make it possible.

As figure 3.6.2. shows, traffic channels occupy a 26-frame multiframe structure and control channels occupy a 51-frame structure.

Figure 3.6.2.





### 3.6.3. THE 26-FRAME TRAFFIC CHANNEL MULTIFRAME

The illustration in figure 3.6.3. shows the time relationship between time-slot, TDMA frame, and the 26-frame multiframe. Some of the times shown are approximate numbers as the GSM Recommendations actually state the exact values as fractions rather than in decimal form (eg. the exact duration of a time-slot is  $15/26\text{ms}$ ).

Note that frame 12 (the 13th frame in the 26 frame sequence) is used by SACCH, the Slow Associated Control Channel which carries link control information to and from the mobile and base-station. The 8 time-slots of frame 12 accommodate 8 SACCHs - one per TCH/FS (full-rate speech). Also note that frame 25 is idle. When the GSM "half-rate" speech channel (TCH/HS) is a reality, this frame will carry the additional 8 SACCHs required. The basic frame/time-slot structure remains identical (full-rate and half-rate channels will coexist) - each time-slot will carry two 11.4Kb/s channels instead of one 22.8Kb/s channel. The SACCH bit rate will remain the same, hence the need for frame 25.

Here is some of the timing arithmetic underlying this structure:

#### 1. Time-slot.

Each time-slot is 156.25 bit durations long and occupies a time interval of 0.577ms.

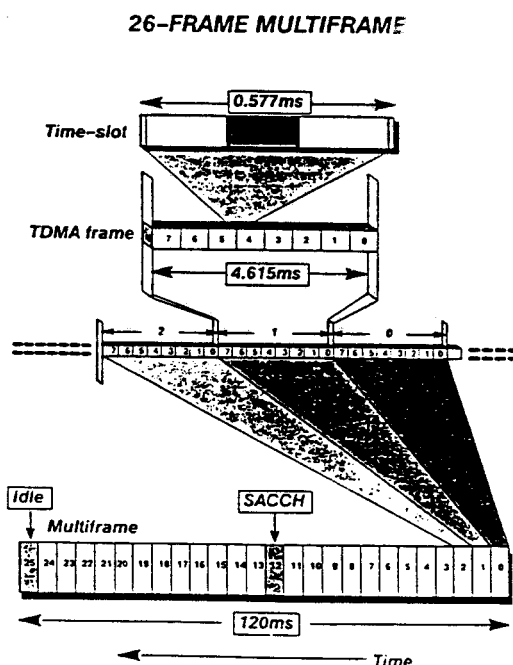
Therefore, transmission bit rate on each RF carrier (to support eight physical channels) =  $156.25/0.577 = 270.8\text{Kb/s}$ .

#### 2. TCH/FS Throughput

TCH/FS uses 24 of the 26 frames in the structure. Each of the 24 time-slots allocated to it during the 120ms multiframe interval provides 114 traffic data bits.

The gross TCH/FS bit rate is therefore:  $\frac{114 \times 24}{120\text{ms}} = 22.8\text{Kb/s}$

Figure 3.6.3.



### **3. SACCH (and Idle Frame) Throughput**

SACCH and the Idle Frame use 1 time-slot per 26-frame multiframe each.

The throughput bit rate of each is therefore:  $\frac{114}{120\text{ms}} = 0.95\text{Kb/s}$

### **4. Physical Channel Throughput**

This is 114 useful data bits per frame, for 26 frames in 120ms = 24.7Kb/s. Adding TCH/FS throughput, to that of SACCH and the idle frame (0.95Kb/s each) confirms this.

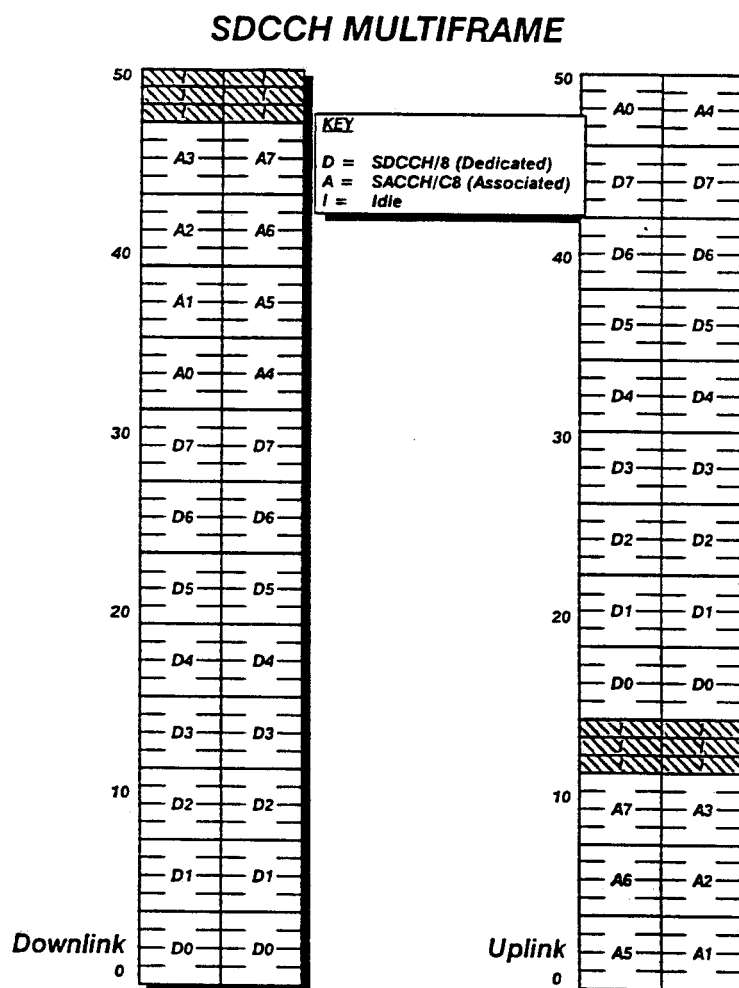


### 3.6.5. THE 51-FRAME CONTROL CHANNEL MULTIFRAME - SDCCH AND SACCH/C

The in figure 3.6.5. shows the 51-frame structure used to accommodate 8 SDCCHs although, as it takes two repetitions of the multiframe to complete the entire sequence, it may be more logical to think of it as a 102-frame structure! This structure will be used on a physical channel selected by the system operator - it is not placed in a time-slot or on an RF carrier defined by GSM Recommendations.

Note that the 8 SACCHs (shaded) are associated with the 8 SDCCHs. It is important to remember that each SDCCH has an SACCH just like a traffic channel.

Figure 3.6.5.





### 3.6.7 SUPERFRAMES AND HYPERFRAMES

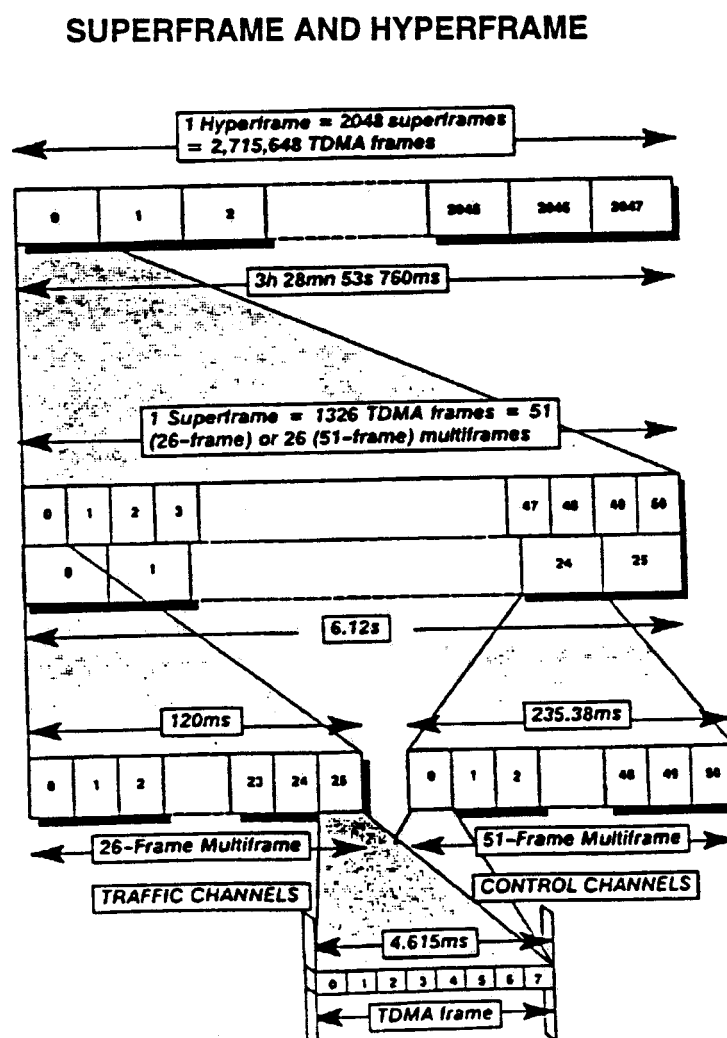
It is not by accident that the control channel multiframe is not a direct multiple of the traffic channel multiframe. From the diagram, it can be seen that any given frame number will only occur simultaneously in both multiframes every 1326 TDMA frames ( $26 \times 51$ ). This number of TDMA frames is termed a "superframe" and it takes 6.12s to transmit. This arrangement means that the timing of the traffic channel multiframe is always moving in relation to that of the control channel multiframe and this enables a receiver to receive and decode all the control channels.

If the two multiframes were exact multiples of each other, then control channel time-slots would be permanently 'masked' by traffic channel time-slot activity. This changing relationship between the two multiframes is particularly important, for example, to a mobile which needs to be able to monitor and report the RSSIs of up to six target cells (it needs to be able to 'see' all the BCCHs of those cells in order to do this).

The "hyperframe" consists of 2048 superframes - this is used in connection with enciphering and has no other purpose. It has a duration of over three hours.

The make up of these larger structures is shown in figure 3.6.7

Fig 3.6.7



### 3.6.8. FREQUENCY HOPPING

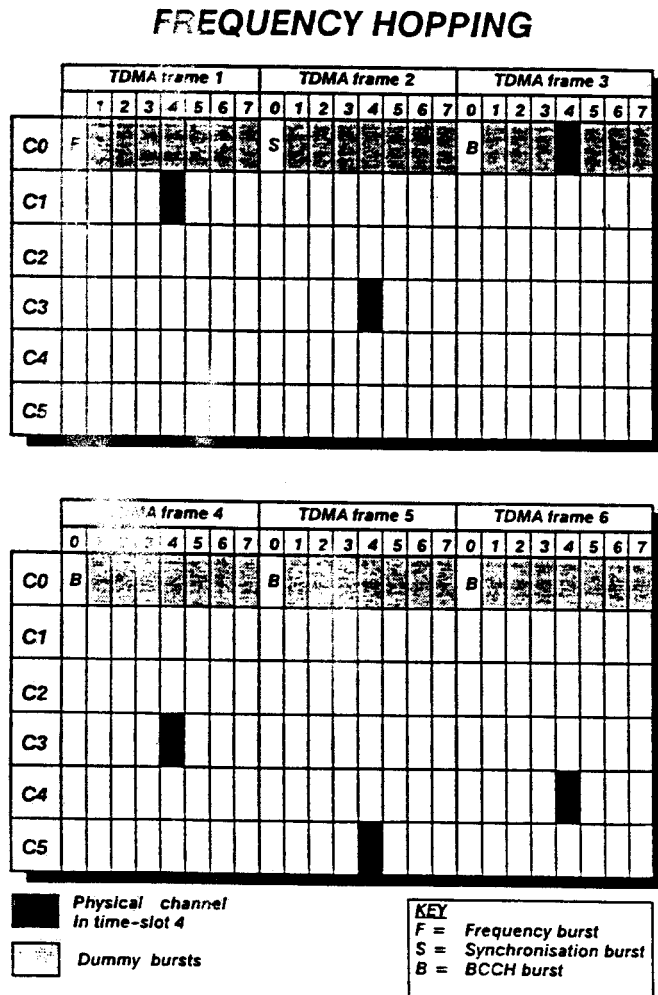
As we saw earlier, frequency hopping is used to overcome multipath propagation effects, which can particularly affect the slow-moving or stationary subscriber. As a spin-off of this, it also adds to the confidentiality of the air-interface. But what is 'frequency hopping'?

Put simply, it is the situation where every burst is transmitted on a different RF carrier frequency. The GSM version is called 'slow frequency hopping' with a rate of 216.68 hops/sec. (=the number of bursts per second of the GSM physical channel). Obviously the hopping does not occur randomly as both transmitter and receiver must hop in synchronisation in accordance with 'frequency hopping table'.

The diagram in figure 3.6.8. illustrates frequency hopping, and also shows the following:

1. BCCH is not frequency hopped. This is because the BCCH in any cell must be transmitted on a dedicated RF carrier, otherwise mobiles would be unable to receive and decode it.
2. The BCCH carrier can be included in the frequency hopping sequence as shown. Many of the bursts transmitted on the BCCH carrier are dummy bursts - therefore, it makes sense to use some of the dummy time-slots to transmit traffic.

Figure 3.6.8.1.

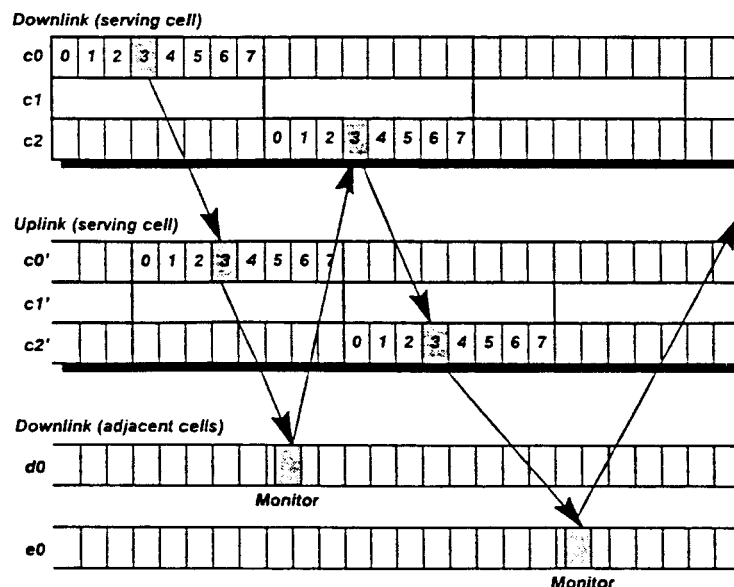


As the mobile only transmits or receives its own physical channel (normally containing TCH and SACCH) for one-eighth of the time, it uses the remaining time to monitor the BCCHs of adjacent 'target' cells. It completes the process every 480ms, or four 26-channel multiframes. The message that it sends to the BSS (on SACCH, uplink) contains the RSSI (Receive Signal Strength Indication) of the adjacent cells, plus that of the link to the BSS itself, plus an indication of the quality of the current connection. This quality measurement is somewhat similar to a bit-error rate test. Just as the mobile completes one series of measurements, it completes sending the previous series to the BSS and starts to send the latest series; thus the processes of compilation and transmission form a continuous cycle.

Figure 3.6.8.2. illustrates a typical activity pattern of a frequency hopping mobile. Notice that the intervals when the mobile is monitoring the BCCHs on carriers d0 and e0 does not neatly fit into the TDMA time-slot structure - this is because the mobile's timing advance is set to suit the range to the serving cell, not to the adjacent cells. As the mobile is simply measuring the RSSI and not seeking to decode the data of those BCCHs, this does not matter.

Figure 3.6.8.2.

### FREQUENCY HOPPING - MOBILE ACTIVITY





**GSM**

**CELLULAR**

**MOBILE**

**TELEPHONE**

**INSTALLATION**

## **GSM CELLULAR MOBILE TELEPHONE INSTALLATION**

### **Introduction**

The following procedure is a comprehensive guide covering the correct installation of GSM cellular mobile telephones.

The procedure is divided into three main areas:

- 1) Pre- installation planning
- 2) Mobile installation procedure
- 3) Post installation checks

# **Pre-Installation Planning**

## PRE-INSTALLATION PLANNING

### GENERAL PRECAUTIONS

Prior to INSTALLATION work commencing ensure that the following precautions are observed.

#### 1) VEHICLE INSPECTION

A standard check list indicating the condition of the vehicle should be completed by the Installer with the CUSTOMERS signatures confirming agreement.

Any defect in the bodywork, trim, electrical features of the vehicle should be brought to the CUSTOMERS attention immediately.

#### 2) CUSTOMER INSTALLATION PREFERENCES

CUSTOMERS should be consulted prior to installation such that he/she may express any preferences as to the location of items such as Handset, Antennas etc.

However should any preference violate any LEGAL/SAFETY REGULATION then the CUSTOMER must be made aware of this and an alternative solution must be employed.

Also any preference which may 'De grade' the performance of the Telephone in any way (eg Antenna location) should be 'pointed out' and then left to the CUSTOMERS discretion.

#### 3) VEHICLE MANUFACTURES INSTALLATION GUIDE

Whenever possible the Manufactures Installation guide should be obtained and be used as the prime reference document for the Installation.

Ensure that any Vehicle warranty is not affected by the Installation

#### 4) INSURANCE

Ensure that adequate Insurance/liability cover is available before undertaking Installation work.

# VEHICLE INSTALLATION REPORT

## CUSTOMER DETAILS

Name.....

Address.....

Telephone no.....

## VEHICLE DETAILS

Make..... Model..... Reg.....

## VEHICLE INSPECTION

Installation Engs name.....

Lights side/front/rear	PRE	POST	Clock	PRE	POST
Lights dip			Radio/cassette		
Lights main			Interior courtesy		
Indicators			Dashboard light		
Hazard lights			Main beam warning light		
Brake lights			Indicator warning		
Fog lights			Wipers front/rear		
Reversing lights			Electric windows		
Heated rear window			Screen washers		
Electric aerial			Cigar lighter		
Trip computer			Electric mirrors		
Interior trim			Electric sunroof		
Exterior bodywork			Horn		

## INSTALLATION INSPECTION

	complies			complies	
Antenna position	Yes	No	Fitting	Yes	No
Transceiver position	Yes	No	Fitting	Yes	No
Handset position	Yes	No	Fitting	Yes	No
Power supply	Yes	No	Fitting	Yes	No
VSP Mic/Spkr	Yes	No	Fitting	Yes	No

## INSTALLATION ENGS. ACCEPTANCE

## INSTALLATION MGR. ACCEPTANCE

## CUSTOMER ACCEPTANCE

## **EQUIPMENT LOCATION**

Full consideration should be given to ensuring that the installation conforms to current safety standards.

Installation in certain vehicles such as petrol tankers may be subject to further safety regulations.

The control, display and cabling should never obscure nor obstruct instruments or vehicle controls, neither should they distract a driver by their operation.

Ideally the equipment should be of correct position and orientation as to be of suitable use by the occupants of the vehicle.

## **Vehicle Protection**

Every precaution must be taken to ensure that NO DAMAGE is caused to the customers vehicle during the Installation.

The Installer must always ensure that:

### **A) CAR CARE**

- 1) Suitable tools are available.
- 2) Clean protective clothing free from sharp buttons and zip fasteners is worn.
- 3) Watches and Jewellery items that may cause paintwork damage should not be worn
- 4) Tools should not be carried in pockets.
- 5) Use protective covers for both interior/exterior work.
- 6) Be careful when drilling holes.(Petrol tanks,wiring looms)  
(Use Manufactures guide).
- 7) If holes are drilled through panels for cable runs then use 'grommets' to prevent cable damage.

### **B) BATTERY ISOLATION**

Whenever possible the vehicle battery should be disconnected  
Note that other electrical equipment may be affected such as:

CAR RADIOS (ANTI THEFT LOCKS)  
CAR ALARMS  
CAR DATA MANAGEMENT SYSTEMS

# **ANTENNA INSTALLATION**



## **ANTENNAS**

Antenna considerations are one of the major factors which will determine the entire success of the installation.

Care must be taken to ensure:

- a) Suitable Professional Antennas are used (not coat hangers etc)
- b) Antenna location is critical to ensure optimum performance.
- c) The actual installation is correct
- d) The antenna is correctly tuned.

### **LOCATION OF ANTENNAS**

In order to create a symmetrical, non-directional radiation pattern:

Mount the antenna VERTICALLY

Mount on a HORIZONTAL GROUND PLANE

Mount Antenna as HIGH as possible

Ensure that all feeder cables are a minimum length as possible ensuring CABLE and CONNECTORS are the correct IMPEDANCE (eg 50 ohms)

Ensure all CABLES are routed neatly and correctly ensuring any connectors are correctly crimped.

#### **DO NOT MOUNT ANTENNA**

Next to vertical pillars/structures (windscreen pillars) as these may act as reflectors/directors

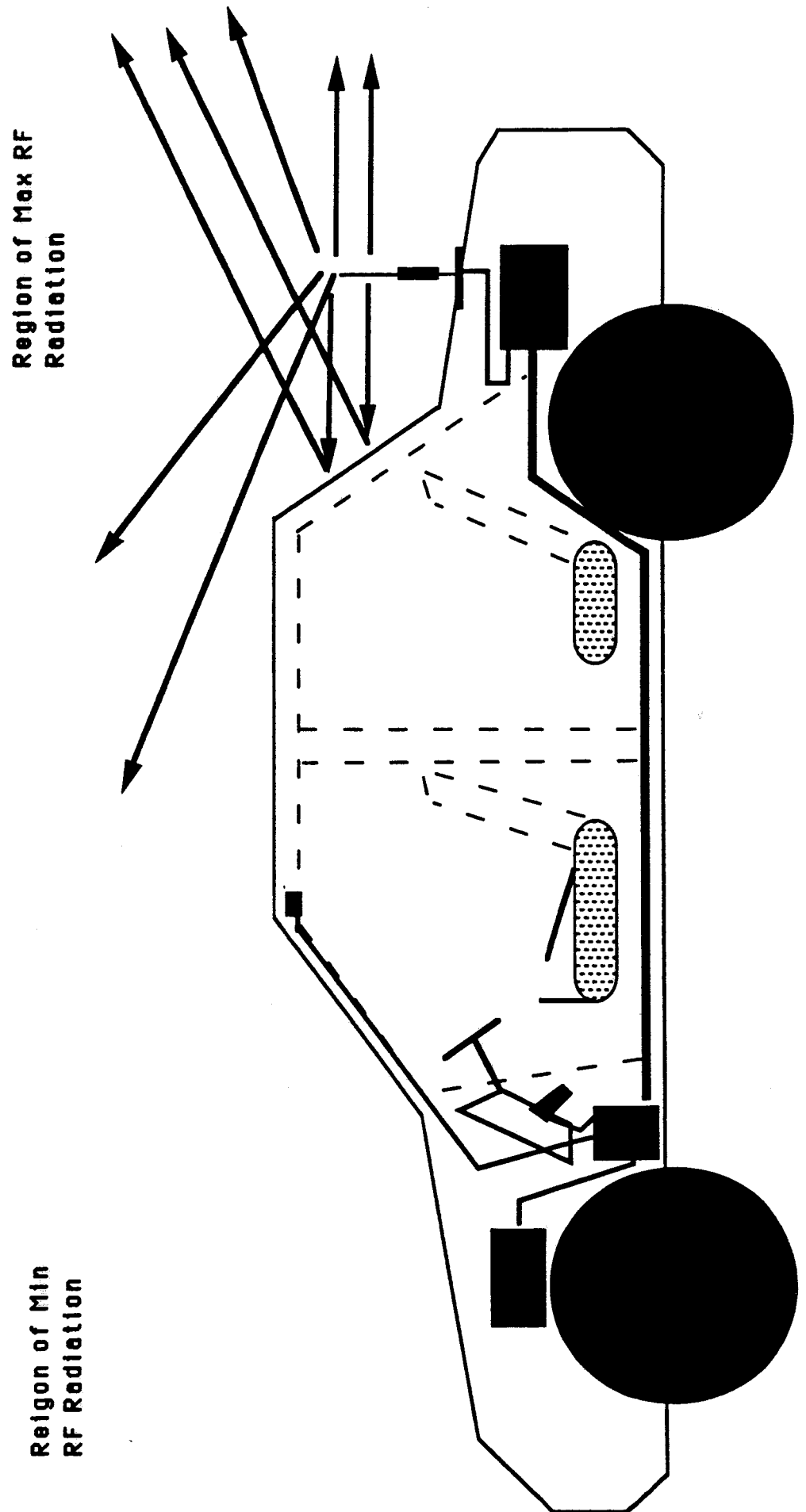
Next to fuel filler caps

Next to sunroofs (minimum quarter wavelength away)

Antenna such that the rod/whip protrude away from the vehicle

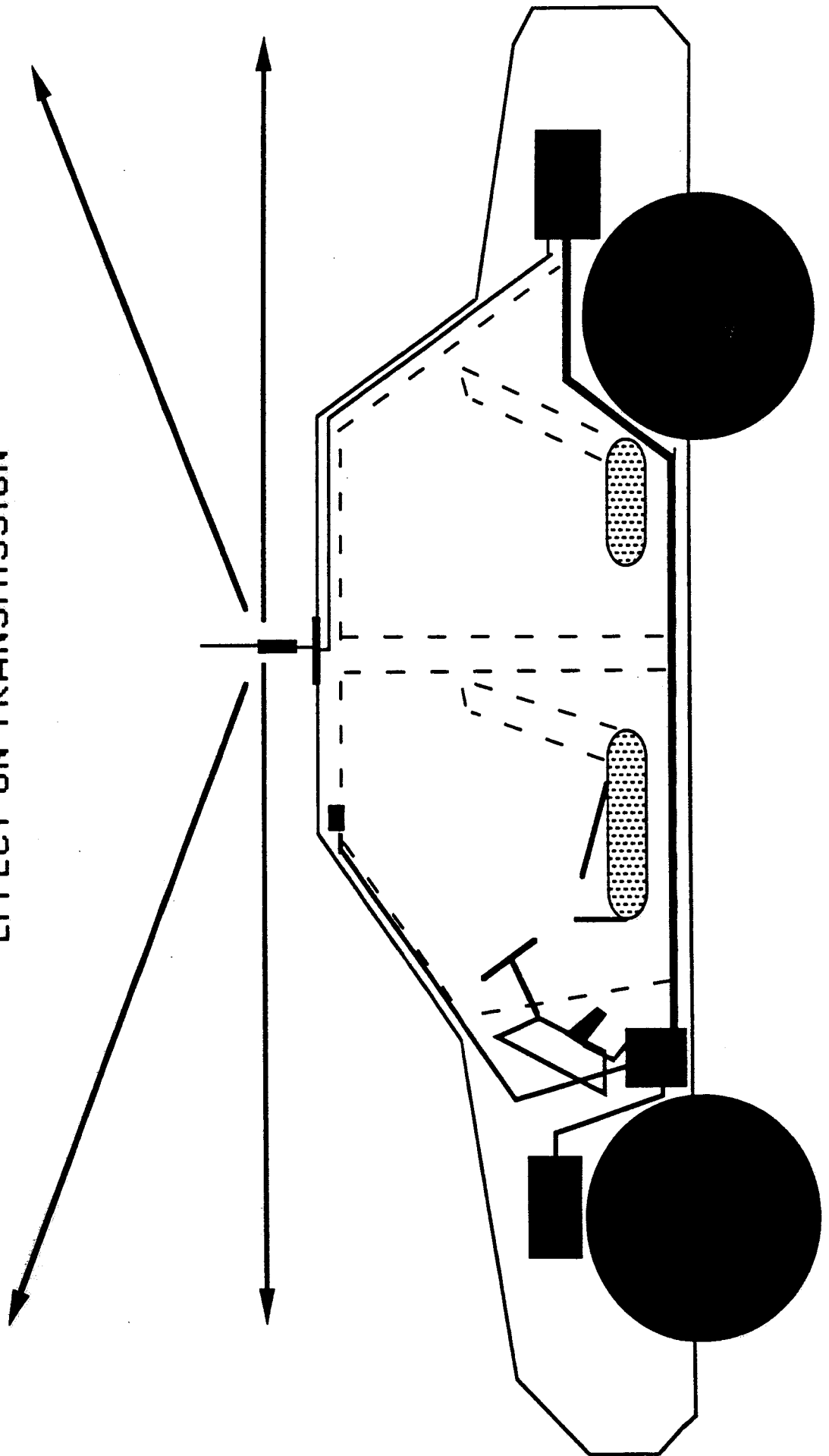
# REAR MOUNTED ANTENNA

## EFFECT ON TRANSMISSION



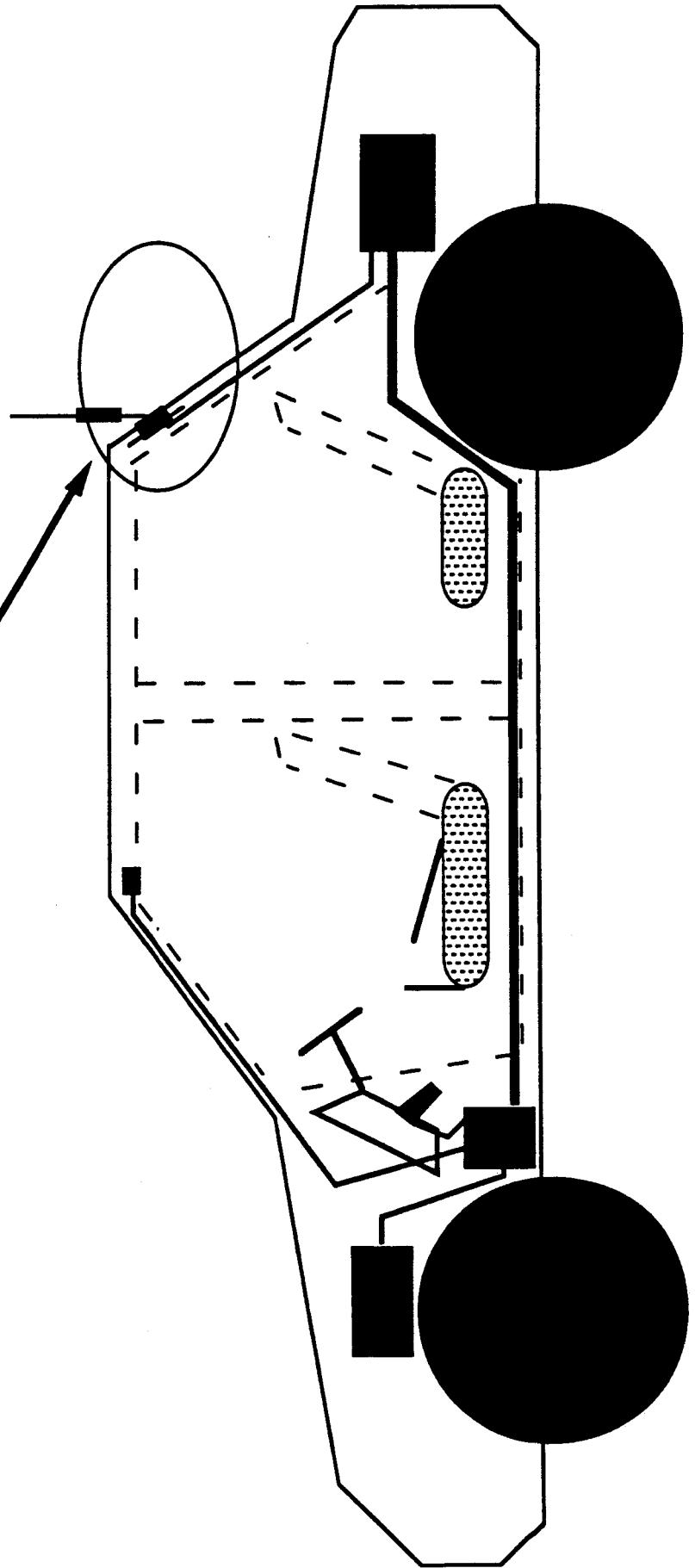
# CENTRE MOUNTED ANTENNA

EFFECT ON TRANSMISSION



## GLASS MOUNTED ANTENNA

COSMETICALLY ATTRACTIVE AND DOES NOT DAMAGE VEHICLE  
HOWEVER THERE IS APPROX 3DB LOSS IN COUPLING THROUGH GLASS



# **MOBILE INSTALLATION PROCEDURE**

## **MOBILE INSTALLATION PROCEDURE**

The Antenna may be mounted first.

The actual radio equipment components should be installed in the following sequence:

- I. Radio (Transceiver)
- II. Handset
- III. Speaker
- IV. V. S. P. - Hands-Free microphone
- V. Control/power and antenna cables

# **TRANSCEIVER INSTALLATION**

### **TRANSCEIVER INSTALLATION**

The Transceiver should be mounted in the vehicle (typically boot area) such that:

- a) It cannot be damaged or ventilated restricted by items carried in the load area
- b) It should be free from moisture, dirt and grease etc.
- c) The mobile should be easily accessible for removal/replacement

**MOBILE EQUIPMENT MUST BE SECURELY MOUNTED IN POSITION.**



## **1. RADIO INSTALLATION**

### **Horizontal Mounting Using Standard Bracket**

Refer to Figure 1. Be sure that the selected mounting location allows for adequate cooling for the radio and provides clearance for the aerial coaxial connector. Position the radio with side closest to the D-type connector facing away from the mounting surface.

**Step 1**      Place the mounting plate on the selected mounting surface and mark the locations for five (5) mounting screws.

**Step 2**      Centre punch the screw locations and drill 1/8 " holes for the mounting screws.

#### **!! WARNING !!**

Exercise extreme care in order to avoid drilling into the fuel tank or some other vital part of the vehicle.

**Step 3**      Secure the mounting plate to the surface with the self-tapping screws.

**Step 4**      Lower the radio onto the mounting plate, so that the rails on the underside of the radio engage the slots in the mounting plate.

**Step 5**      Slide the radio forward until you hear it click which indicates that the radio is secured in place.

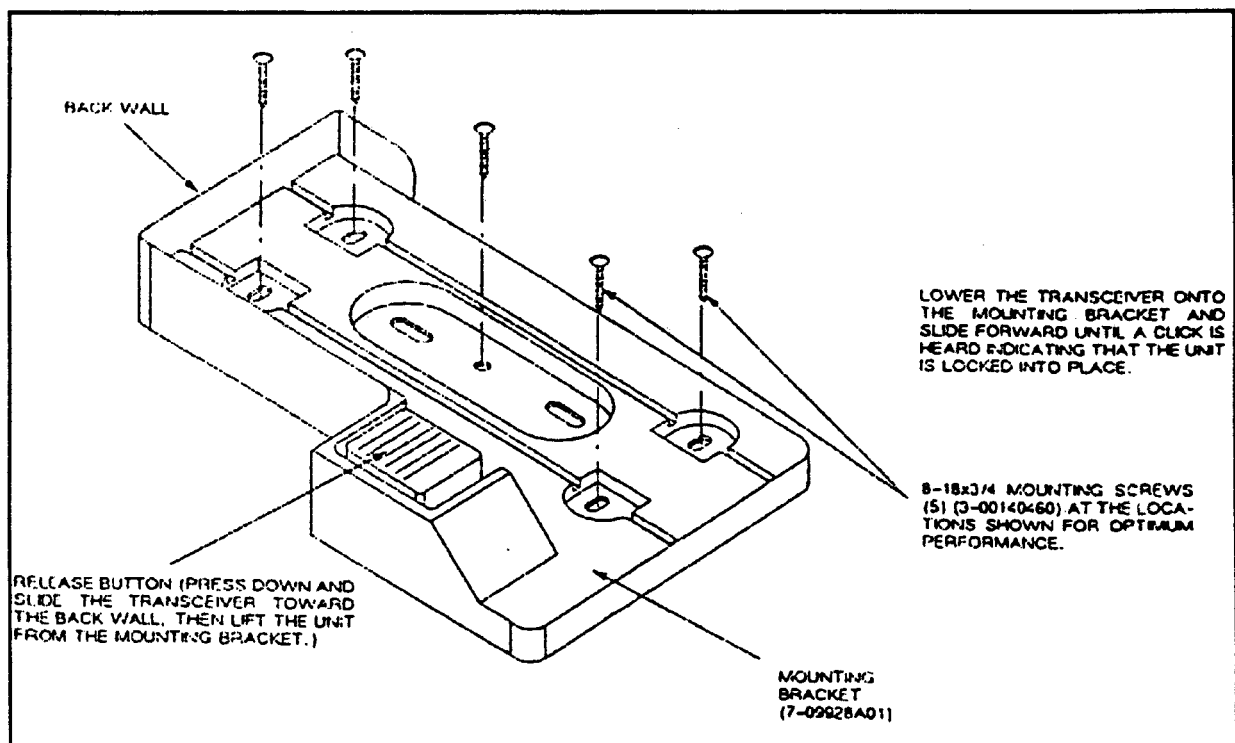


Fig.1 Transceiver Mounting using standard bracket

# **HANDSET INSTALLATION**

## **II HANDSET MOUNTING**

The handset hangs in a standard mounting cup (Figure 2) which can be mounted by itself or by using the adjustable angle bracket (Figure 3).

### **Standard Mounting Cup Alone (All Cup Types)**

- Step 1**      Refer to Figure 2. Ensure that the selected mounting surface is sufficiently strong to support the mounting hardware.
- Step 2**      Depending on the model, use either the hang-up cup itself, or the lower shell as a template to mark the location of the mounting holes (2 or 4 depending upon the model). Then drill 4.1 mm (5/32") holes at the marked locations.
- Step 3**      Use the M5 tapping screws to mount the hang-up cup or the lower shell.
- Step 4**      For two-piece hang-up cup models without a target light, place the upper shell on top of the lower shell and secure them together with the M4 machine screws.

Some two-piece hang-up cup models have optional target lights. Step 5 through 7 apply to those models.

- Step 5**      For two-piece hang-up cup models with a target light, place the upper shell on top of the lower shell, making sure that the target light leads are properly routed to the outside (if used), via the small apertures provided in the lower shell or between the two shells on the mounting cup. This should be the case only if the target light will be used; otherwise, the leads should be cut and left inside the mounting cup shells.
- Step 6**      Using the M4 machine screws, secure the upper shell to the lower shell.
- Step 7**      If the target light is used, connect the leads to the appropriate voltage source in the vehicle (e.g. the accessory fuse in the fuse block).

## INSTALLATION PROCEDURE/ cont...

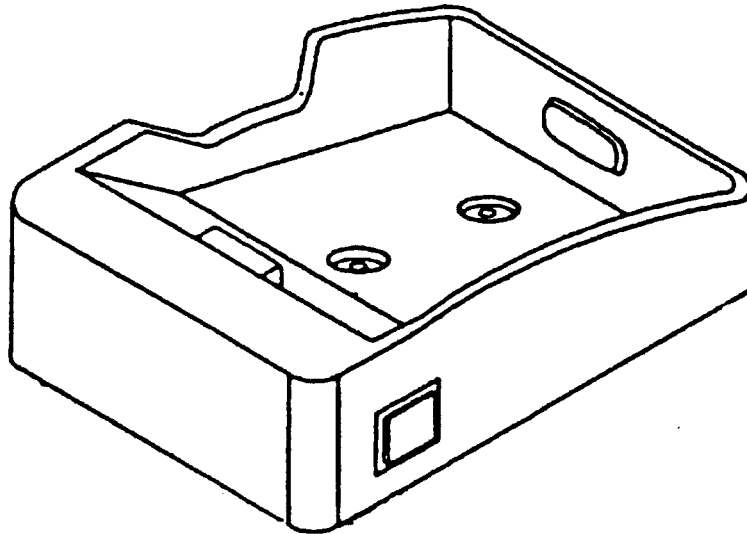


Figure 2 Mounting Cup

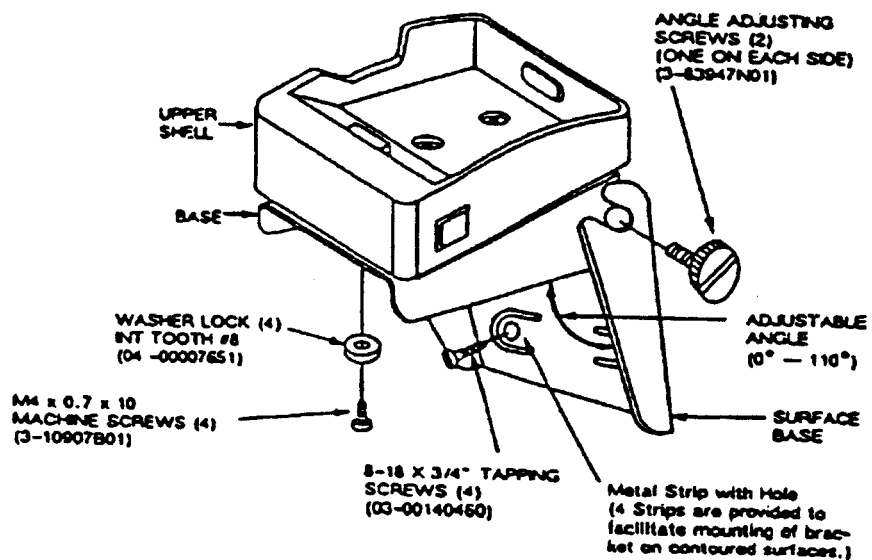


Fig 3 Adjustable Angle Bracket Installation

### **Mounting with Adjustable-Angle Bracket (All Cup Types)**

Refer to Figure 3. Verify that the selected mounting surface is sufficiently strong to support the mounting hardware. The mounting surface does not have to be completely flat since the metal strips on the bracket can accommodate mounting surfaces that are slightly curved.

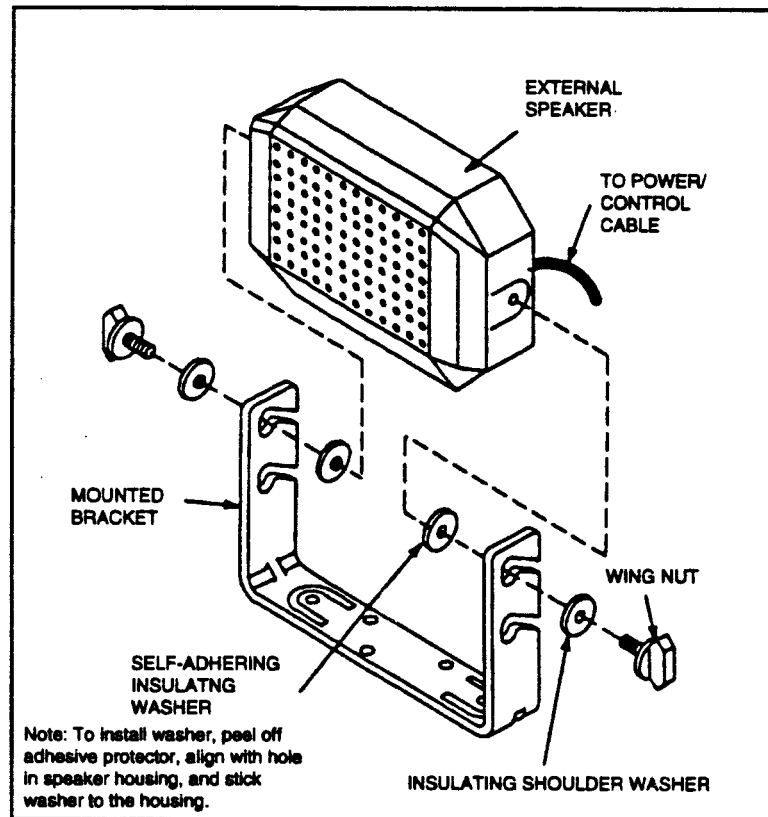
# **SPEAKER INSTALLATION**

## Speaker Installation

The external Speaker should preferably be mounted onto the passenger side of the console.

This provides ease of mounting and will help to prevent any audio feedback problems in association the V. S. P. Microphone.

The speaker housing is electrically insulated from the mounting bracket by insulating washers. It is important to prevent the speaker housing from contacting any metal in the vehicle, such as the dashboard or console. The speaker housing is connected to ground, and contacting any external metal will cause a ground loop which may introduce alternator whine or other undesirable interference.



*Speaker Installation*



# **MICROPHONE INSTALLATION**

## V. S. P. Hands-Free Microphone

The simplest and most effective method of mounting the Hands Free microphone is to clip it directly onto the sun visor or attach it to the drivers side pillar.

The microphone cable may be neatly run behind the trim, down the drivers side pillar and under the console to connect into the main loom.

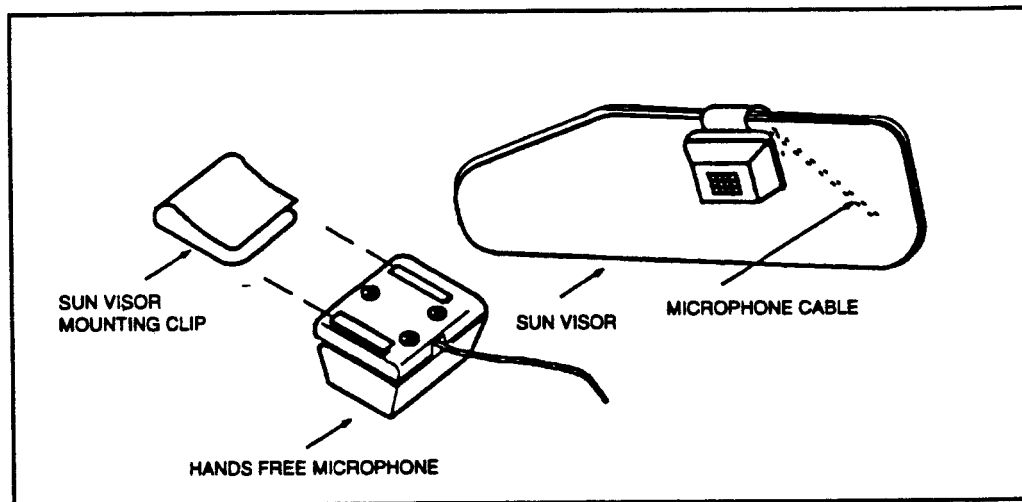
Special considerations should be given to the V. S. P. Microphone mounting since its location affects the Hands Free Performance.

Ideally the V. S. P. Microphone should NEVER BE INSTALLED near the side window or in a location where the background noise will be significant.

Also to help eliminate any excessive feedback place the Microphone at least 50 cm away from the speaker.

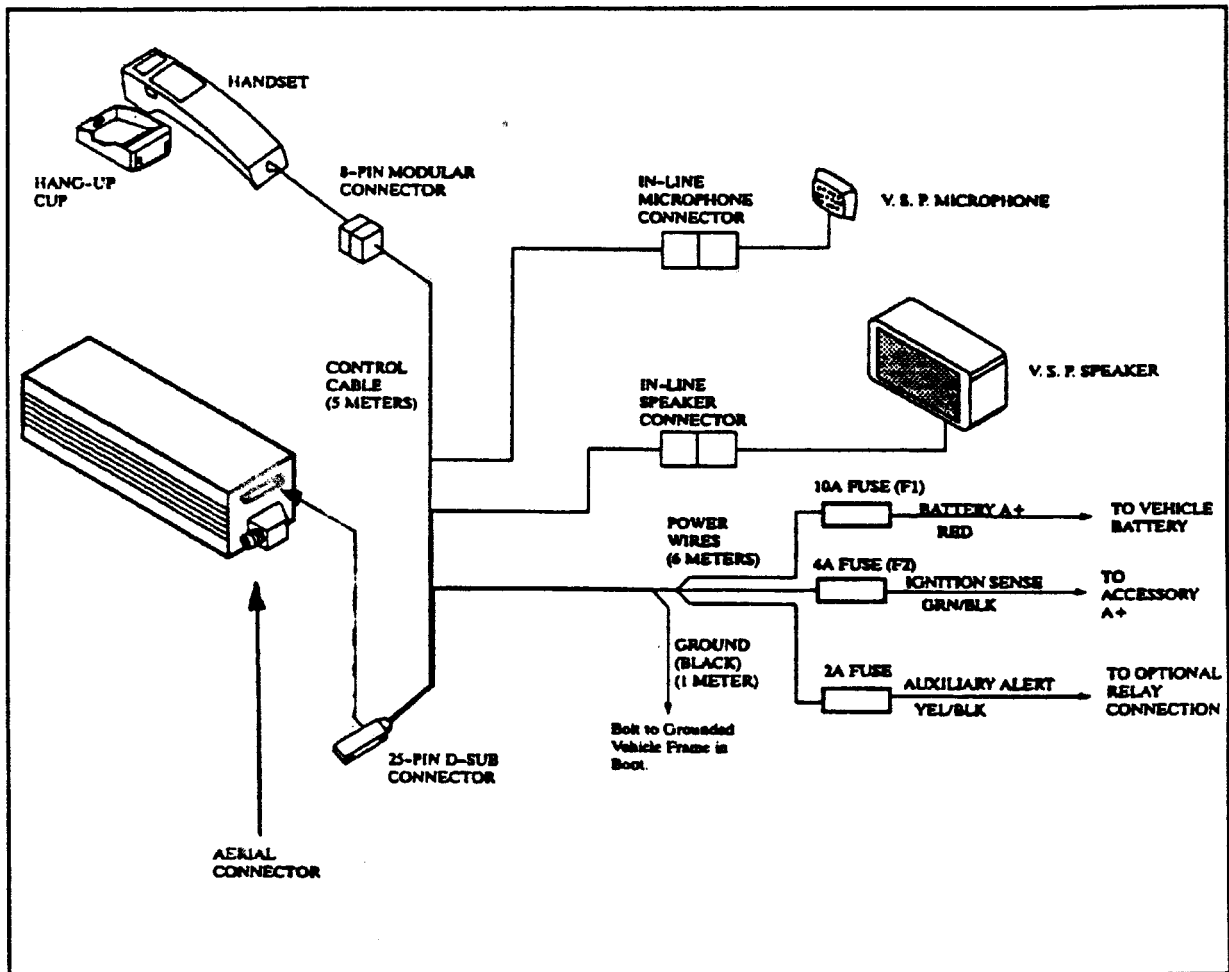
The Microphone and Speaker should never be facing each other.

The Microphone should not be placed near fans/vents as any ambient noise levels can cause problems.



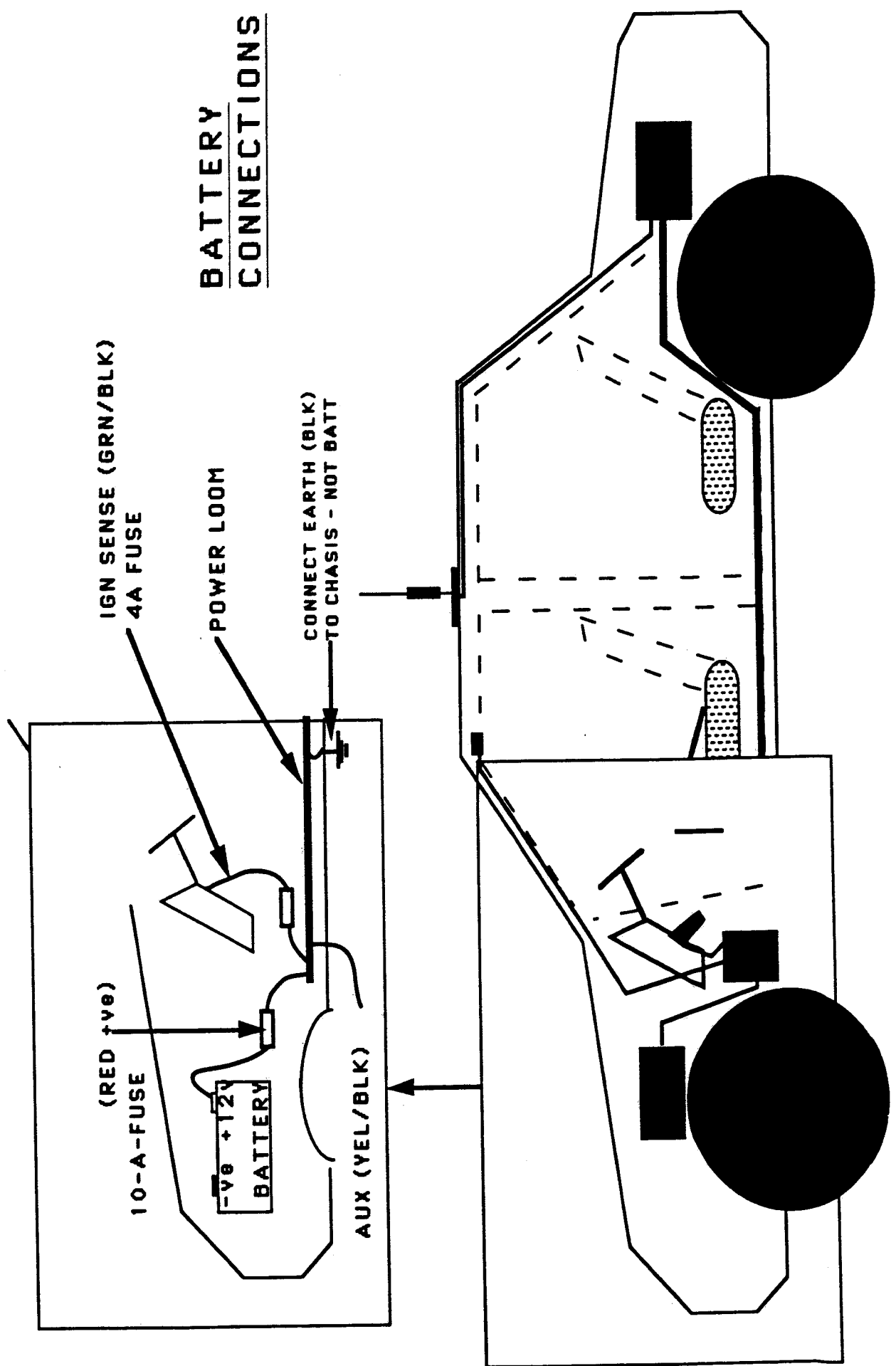
*Sun Visor Clip Installation*

# **POWER CABLE INSTALLATION**



*Cable Connection Detail*

# BATTERY CONNECTIONS



## V. POWER/CONTROL CABLE AND AERIAL CABLE INSTALLATION

- Step 1**      Route the power/control cable through the trunk partition into the passenger's compartment. Run the handset connector to the approximate location of the handset. Run the external speaker connector to the approximate location of the external speaker.

### IMPORTANT

**DO NOT PULL** on the connector housings while routing the cable.

- Step 2**      Route the power cable (2 red # 19 AWG) A + supply, 1 green-black ignition sense, and 1 yellow-black auxiliary alert into the engine compartment. If necessary, cut a hole in the fire wall for the power cables. This hole must have a diameter of the 2.5 cm (1") to fit the supplied rubber grommet.

### NOTE

1.              If the fuse block is located in the passenger's compartment, do not pull the ignition sense line (green/black) through.
2.              If the auxiliary alert device is to be used in the passenger's compartment, do not pull the auxiliary alert line (yellow/black) through.

- Step 3**      Install and route the aerial coaxial cable. Refer to the instruction section included with the aerial for details on how to prepare, route, and install the aerial coaxial cable.

## CONNECTING THE CABLES

- Step 1**      Connect the coaxial cable to the radio and to the aerial.
- Step 2**      Bolt the black leads of the power/control cable to the vehicle frame in the trunk compartment.

### IMPORTANT

Special attention should be given to locating a good vehicle ground. Optimum radio performance can only be achieved with a ground connection having a very low resistance. The vehicle frame makes the best ground, but body structural reinforcement members are also suitable for grounding purposes. One of the bolts under the mat on the boot floor may also be used. Thoroughly clean the bolt and boot floor if the black lead lug is to be bolted to the floor.

- Step 3**      Connect the D-type connector on the power/control cable to the radio set.
- Step 4**      Check the power cable fuses (F1 and F2) and make sure that the correct sizes and types are supplied.
- Step 5**      The fused green/black ignition sense lead (F2, 4A) of the power cable should normally be connected to an accessory A + terminal at the vehicle fuse block. The lead may optionally be left unterminated. Refer to Table 1.

## IMPORTANT

For proper operation of the convenience on/off feature, the ignition sense lead should be connected to an accessory et terminal at the vehicle fuse block.

- Step 6      Cut the red wire connected to the supplied F1, 10A fuse holder (to position the fuse in the desired location) and connect one end of the fused red lead to the positive (ungrounded) battery terminal, using the lug supplied with the cable kit. Strip the other end of the fused red lead approximately 1/2" /12.7 mm) and insert into one end of the supplied blue crimpstyle, in-line connector. Crimp the connector down on the red wire.
- Step 7      Insert the two red # 18 AWG (# 19 SWG) A + supply wires from the cable kit into the other end of the blue connector. Crimp the connector down on these two wires.
- Step 8      Connect the external speaker connector from the cable kit into the connector from the external speaker. Connect the connector from the V. S. P. Connect the connector from the V. S. P. microphone into the mating connector in the radio power/cable kit.
- Step 9      Check the power cable A + connection and verify that the lead is connected to the correct polarity.
- Step 10     Pull all excess cabling into the boot. Using the supplied cable clamps, clamp the cables to the vehicle body or chassis.
- Step 11     Carefully inspect all cables and connections: then insert the 10A fuse F1 into the fuseholder on the red lead and the 4A fuse F2 in the fuseholder on the green/black lead (if connected in Step 5).

### Auxiliary Alert

Each mobile radiotelephone is provided with a dedicated wire (yellow-black) in the radio power/control cable that grounds the circuit for the first five times that the mobile unit rings (provided that the user has properly enabled the auxiliary alert feature). This closure has a fixed duration of one second for each ring.

Although the auxiliary alert line has a 1/2 ampere capacity, it is recommended that the connection to the auxiliary alert device (such as the vehicle horn, headlights, etc.) be made through a suitable relay using a 2A slow-blow fuse for circuit protection.

Alternatively, the auxiliary alert line can be connected to a supplemental ringer or light source mounted within the passenger compartment. This can be useful when the vehicle is parked (with the ignition off) in very noisy environments.

**Note:** The Auxiliary Alert wire is inactive on the Pre-commercial Product. The wire should be left unterminated.

### NOTE

Local regulations may forbid the use of horns and/or flashing headlights as auxiliary alert devices. Consequently, the auxiliary alert external signalling feature **should not be used** in these areas.

## NOTE

Local regulations may be forbid the use of horns and/or flashing headlights as auxiliary alert devices. Consequently, the auxiliary alert external signalling feature should not be used in these areas.

**Table 1** Ignition Sense Lead Connections

<b>Sense Lead Connections</b>	<b>Initial Connections</b>	<b>Action</b>	<b>Result</b>
Ignition	Mobile Off, Ignition Off	Depress Power	Mobile on and locked.
	Mobile Off, Ignition On	Depress Power	Mobile on
	Mobile On, Ignition Off	Depress Power	Mobile off.
	Mobile On, Ignition On	Depress Power	Mobile off.
	Mobile Off, Ignition Off	Ignition On	Mobile on/off. Will power up in same state as the Mobile was before ignition turned off.
	Mobile Off, Ignition On	Ignition Off	Mobile off.
	Mobile On, Ignition Off	Ignition On	Mobile on with existing lock state.
	Mobile On, Ignition On	Ignition Off	Mobile off.
Not connected	Ignition Not Connected Mobile Off	Depress Power	Mobile on and locked.
	Mobile On Ignition Not Connected	Depress Power	Mobile off. Mobile on and locked.

The following recommended transmitter installation and test procedures are suggested for vehicles with electronic anti-skid braking systems.



## **INSTALLATION SUGGESTIONS**

Locate the braking modulator box in the vehicle. A service manual may be helpful to aid in the location of the braking modulator box. Perform transmitter installation in accordance with the following recommended procedure:

- If the braking modulator box is mounted on the right side of the vehicle, mount the transmitter on the left side of the boot to give as much space as possible between the braking modulator box and the transmitter. If the braking modulator box is mounted on the left side, reverse the procedure.
- The antenna should be mounted on the opposite side of the car boot from the braking modulator box.
- Route all cables along the center or on the opposite side of the vehicle from the braking modulator box.
- Do NOT operate the transmitter while the vehicle is in motion with the boot lid open.

## **TEST PROCEDURE**

A detailed procedure to check that the radio operation does not interfere with brake or guidance systems is provided in the section entitled performance checks. If the vehicle is equipped with such a system, it is imperative that this procedure be performed before operating the radio.

## **POSSIBLE VEHICULAR INTERFERENCE WITH RADIO OPERATION**

Many parts of a vehicle can product electrical noise that interferences with the mobile radio system operation. The ignition system is the most common source of interfering electrical noise. During the installation planning, it is a good idea to check the condition of the ignition wiring and the connections to the vehicle battery. Be sure low resistance connections exist between the battery negative terminal, vehicle chassis, and the engine block. All wire connections should be clean and tight.

See also the section entitled "reducing noise interference in mobile two way radio installations".

On duplex radios, interference can be produced by non-electrical components as well. Any two metal pieces rubbing together (seat springs, shift levers, trunk and hood lids, exhaust pipes, etc.) in close proximity of the antenna can cause severe receiver interference.

Antenna mounting locations should be experimented with before actual antenna installation is made.

# **POST INSTALLATION**

## **CHECKS**

## **POST INSTALLATION CHECKS**

The only Post Installation checks possible at present are as follows:

1. An on air system test, making and receiving a call.
2. If you have a GSM service box you can test some parts of the installation as described in section 6.
3. It is also recommended that a test is carried out to check the Anti-Brake skidding feature which is present on some cars.
  - i) Switch on the ignition (with fans and radio off). Listen for the motor noise of the pump for the brakes.
  - ii) Press brake pedal several times and listen for sound of pump.
  - iii) Perform this test **before** and **after** installation of the GSM cellphone.
  - iv) If the pump does not start or stop correctly **before** installation of of the GSM cellphone, bring this to the attention of the customer.
  - v) If the pump does not start or stop correctly **after** installation of the GSM phone, disconnect the phone and seek further assistance.

These are all the Post Installation checks that can be completed at present.

**TROUBLE SHOOTING**

**THE CUSTOMERS GSM PHONE**

## **FAULT FINDING PROCEDURES**

- A) Using replacement parts to isolate users cable loom, handset, transceiver and hands free mic/speaker.

Pages 1 to 7 guide the service technician through a simple flow chart procedure to isolate the problem.

- B) Using the special GSM service test box.

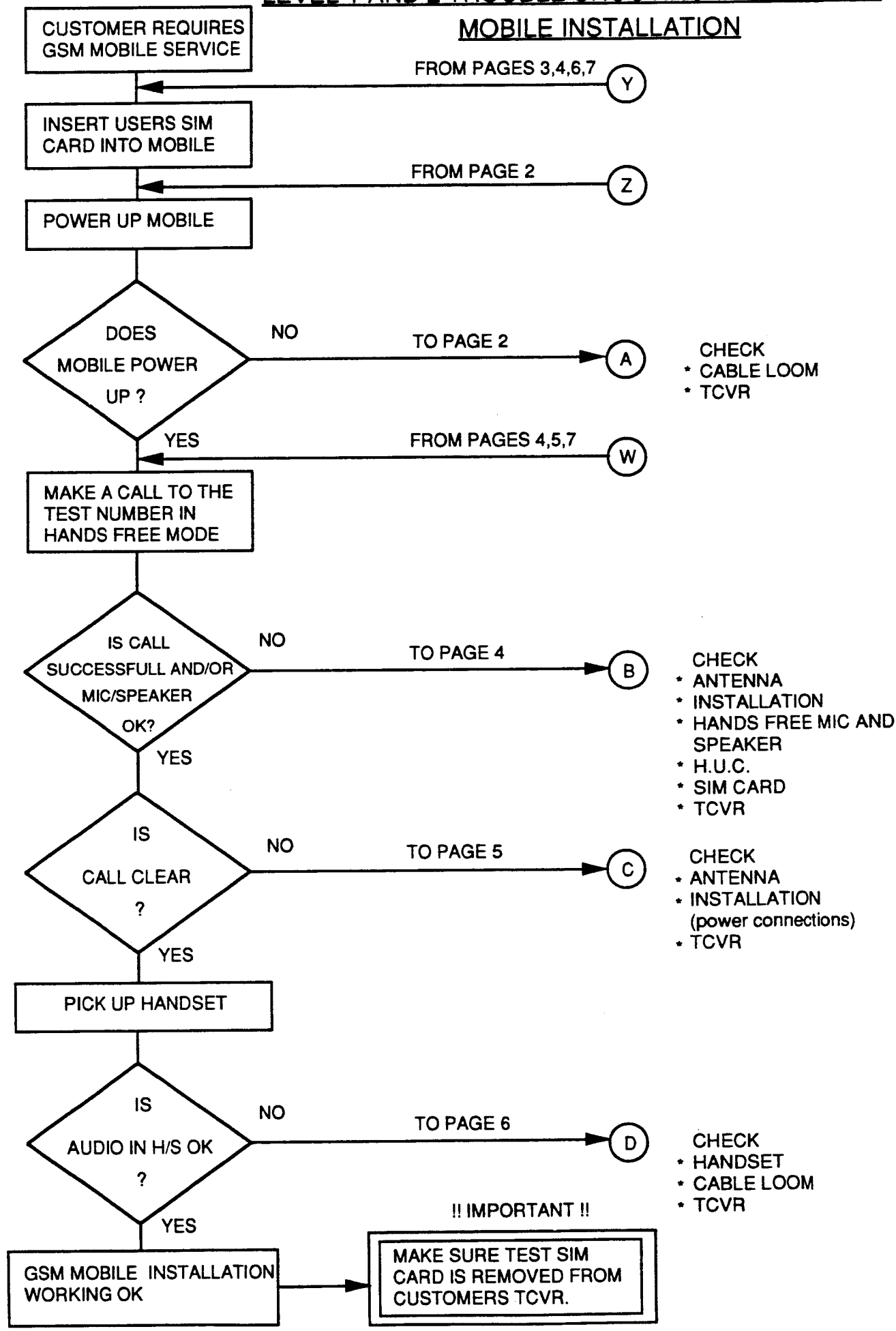
With the aid of this special test box it is possible to test the mobile telephone installation in the customers vehicle.

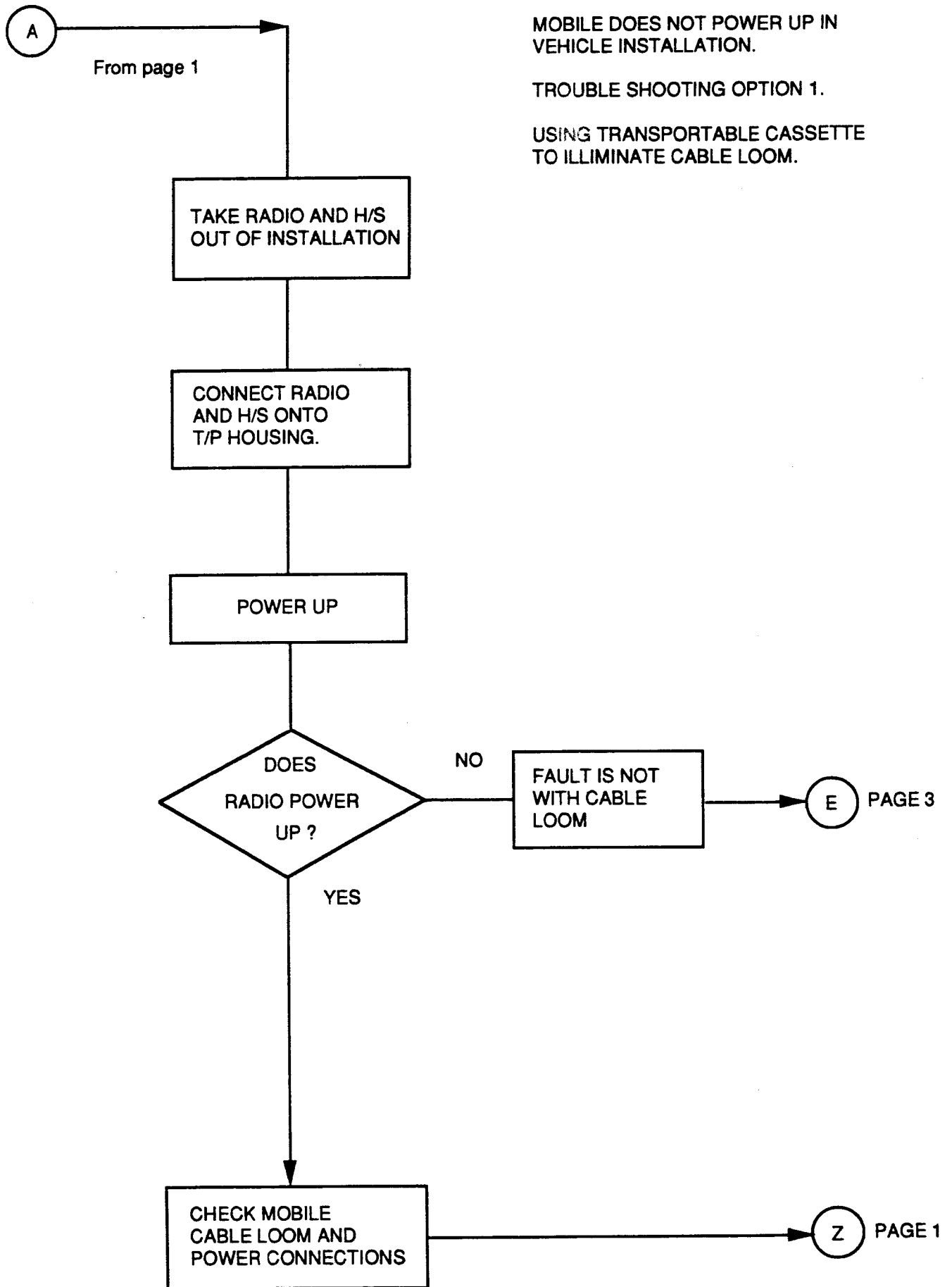
The following modules or devices can be tested.

- \* Handset
- \* Microphone
- \* Speaker
- \* Cable loom power connections
- \* External data box interface (ISDN box) or other peripheral

See GSM Test Box operating procedure later in this section for further details.

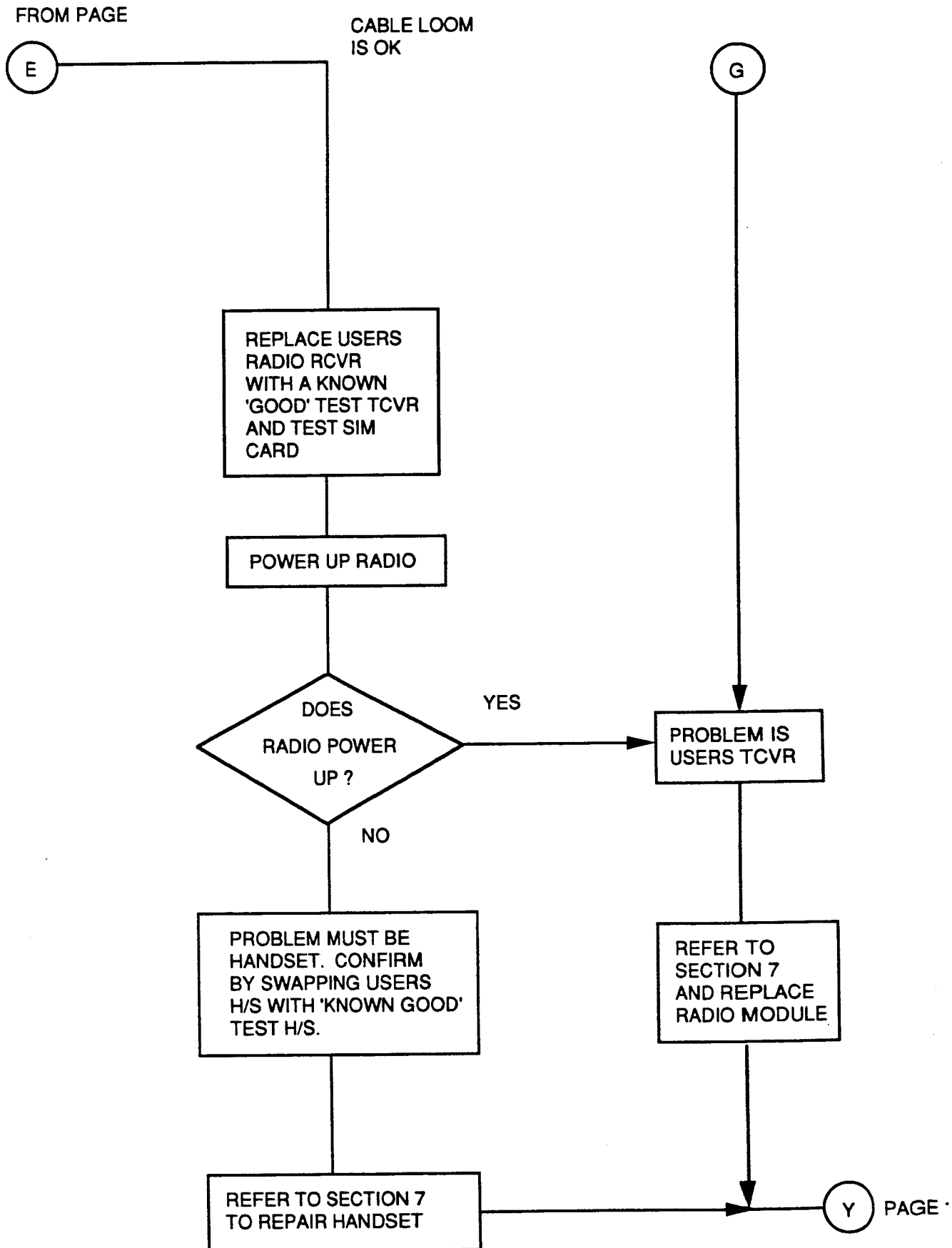
**LEVEL 1 AND 2 TROUBLE SHOOTING FLOW CHART**  
**MOBILE INSTALLATION**





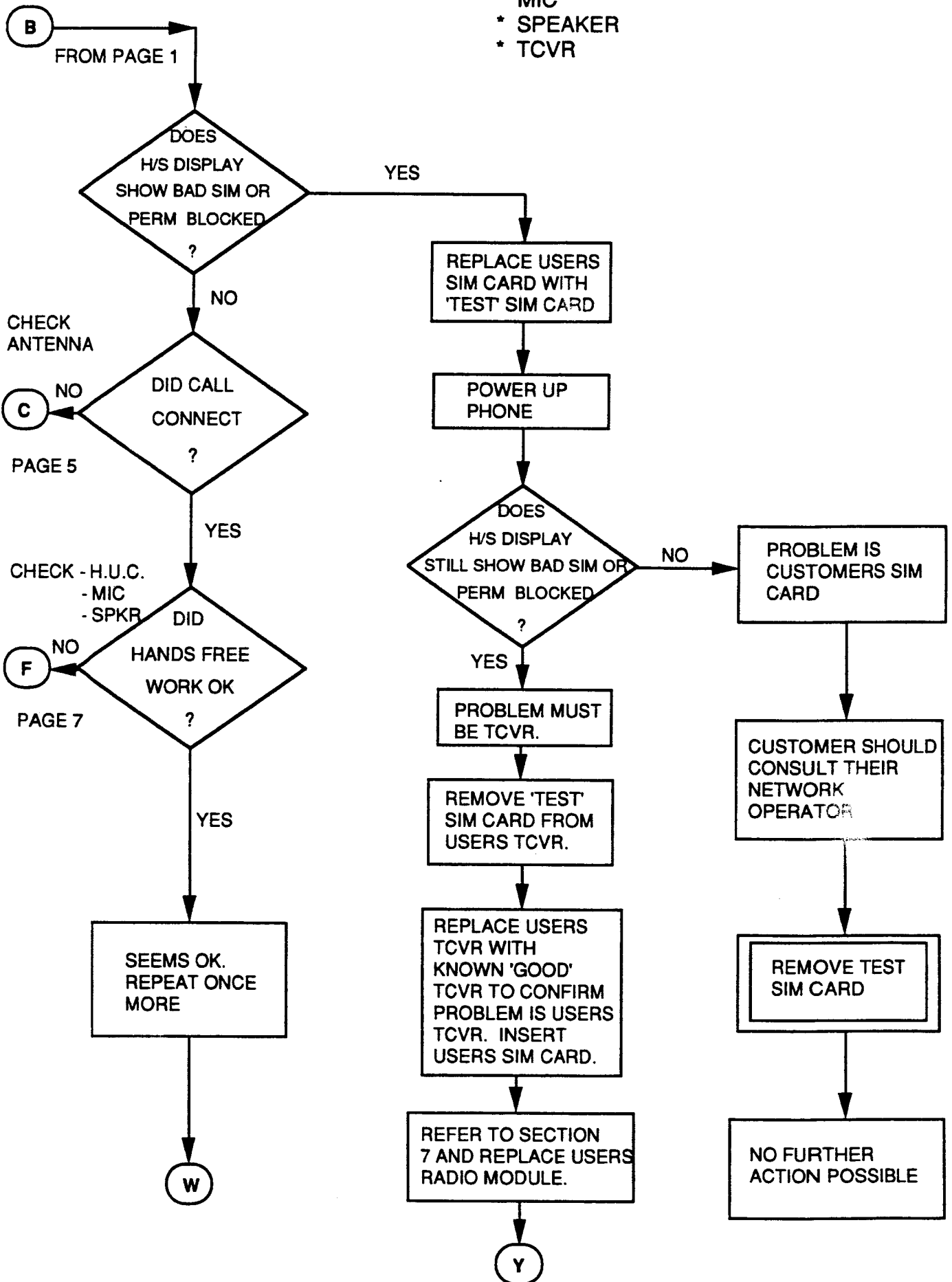
## ISOLATE CUSTOMERS TRANSCEIVER

3



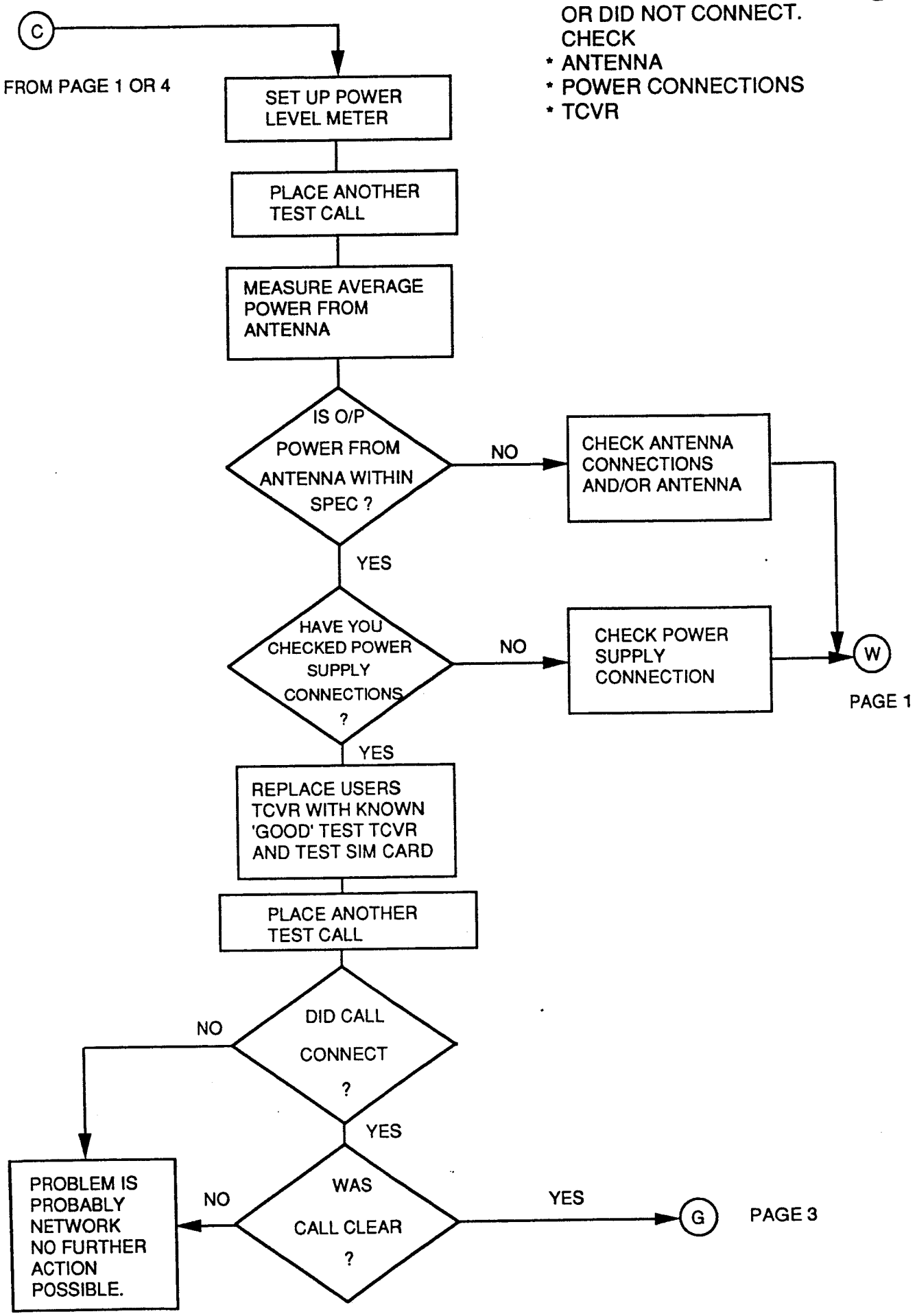


- \* SIM CARD
- \* MIC
- \* SPEAKER
- \* TCVR



FROM PAGE 1 OR 4

CALL IS NOT CLEAR  
OR DID NOT CONNECT.  
CHECK  
\* ANTENNA  
\* POWER CONNECTIONS  
\* TCVR

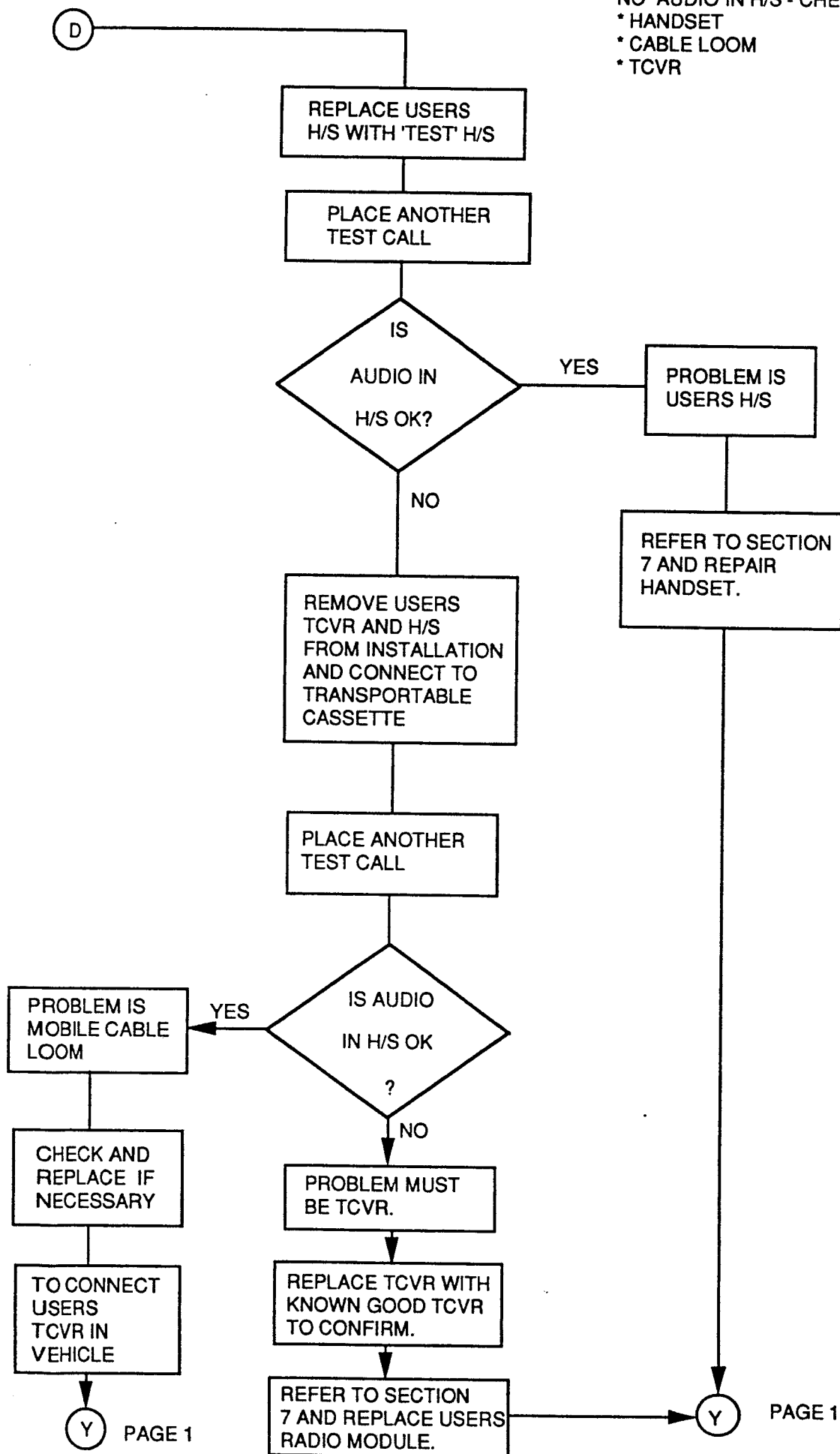


NO AUDIO IN H/S - CHECK.

\* HANDSET

\* CABLE LOOM

\* TCVR





GSM

TEST BOX

OPERATING

PROCEDURE

## **GSM TEST BOX OPERATING PROCEDURE**

### **Introduction**

It is possible using the automatic test box to test certain parts of the car kit, please see list below for checks which can be carried out using the Test Box. The test box will indicate if a fault is present on a certain part of the installation or not.

### **Test Box Description**

The test box is similar to a standard GSM Mobile except that the RF Board has been removed and replaced with a clock for running the microprocessor and a load for testing the battery supply. The test box simply plugs into the power loom in place of the customers GSM Mobile, it is then controlled from the handset at the front of the car, assuming the customers handset is not faulty.

### **Test Box Operation**

Once the test box is connected you can then select using the handset which part of the installation you want to test and then which individual part of that section you want to test. Initially all messages in the display will appear in English.

Example.

Select Handset Test

Select Audio Section

Handset Speaker Test

To select a test or bypass it and goto the next test you use the RED and GREEN keys on the handset;

**RED** Key will in effect say NO to that test or return the user to the start of the test.

**GREEN** key will in effect say YES to that test or proceed to the next stage in the test.

## **GSM TEST BOX OPERATING PROCEDURE**

Once the test has been selected the handset will then automatically conduct that test, the result of which will be obvious from the test if it has passed or failed.

Listed below are the tests which can be performed by the test box.

### **List of Tests Performed.**

1. Initial Power Up Test Selection
2. Select Language Sequence
3. Power Calibration
4. Power Supply test
5. DSC bus connection test

#### **Handset #test \***

6. LED test
7. Key test
8. Display test
9. Backlight test
10. Hook-switch test
11. Character test

#### **Audio test \***

12. Volume test
13. Side tone test
14. Microphone test
15. Earpiece test

#### **Fixed Installation test \***

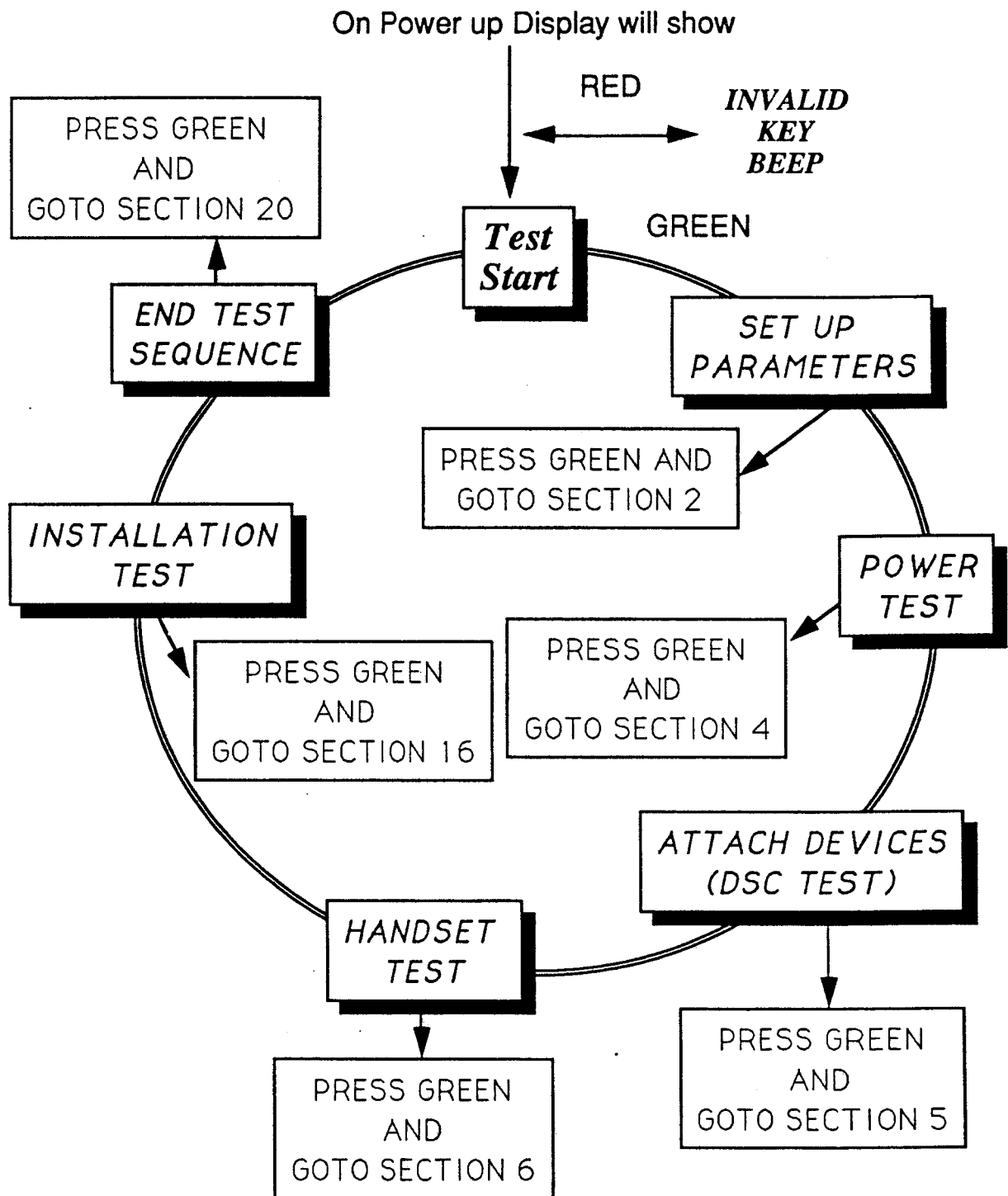
16. Handsfree Loudspeaker test
17. Handsfree Microphone test
18. Ignition test
19. Mute/Alarm test
20. End of Test Sequences

\* These indicate separate sections of the test, which then break down into more detailed tests for that section as shown above.

Following on are the flow charts which describe how each test procedure occurs and what to change if a fault occurs, this is only a basic guide as to which module to change.

# GSM MOBILE AUTO TEST PROCEDURES

## 1 Test Selection

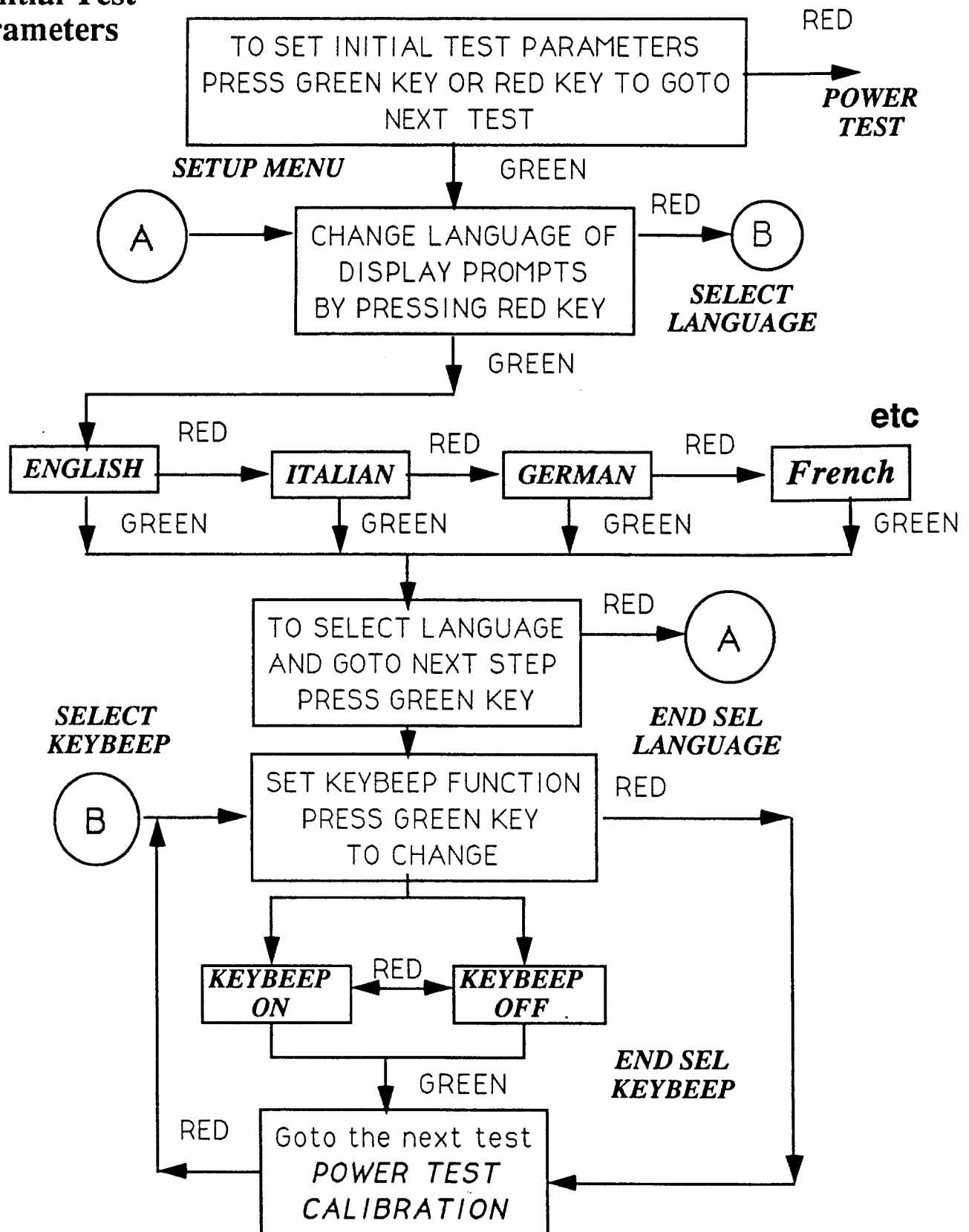


Press Red key to step from test to test and  
Green key to select test.



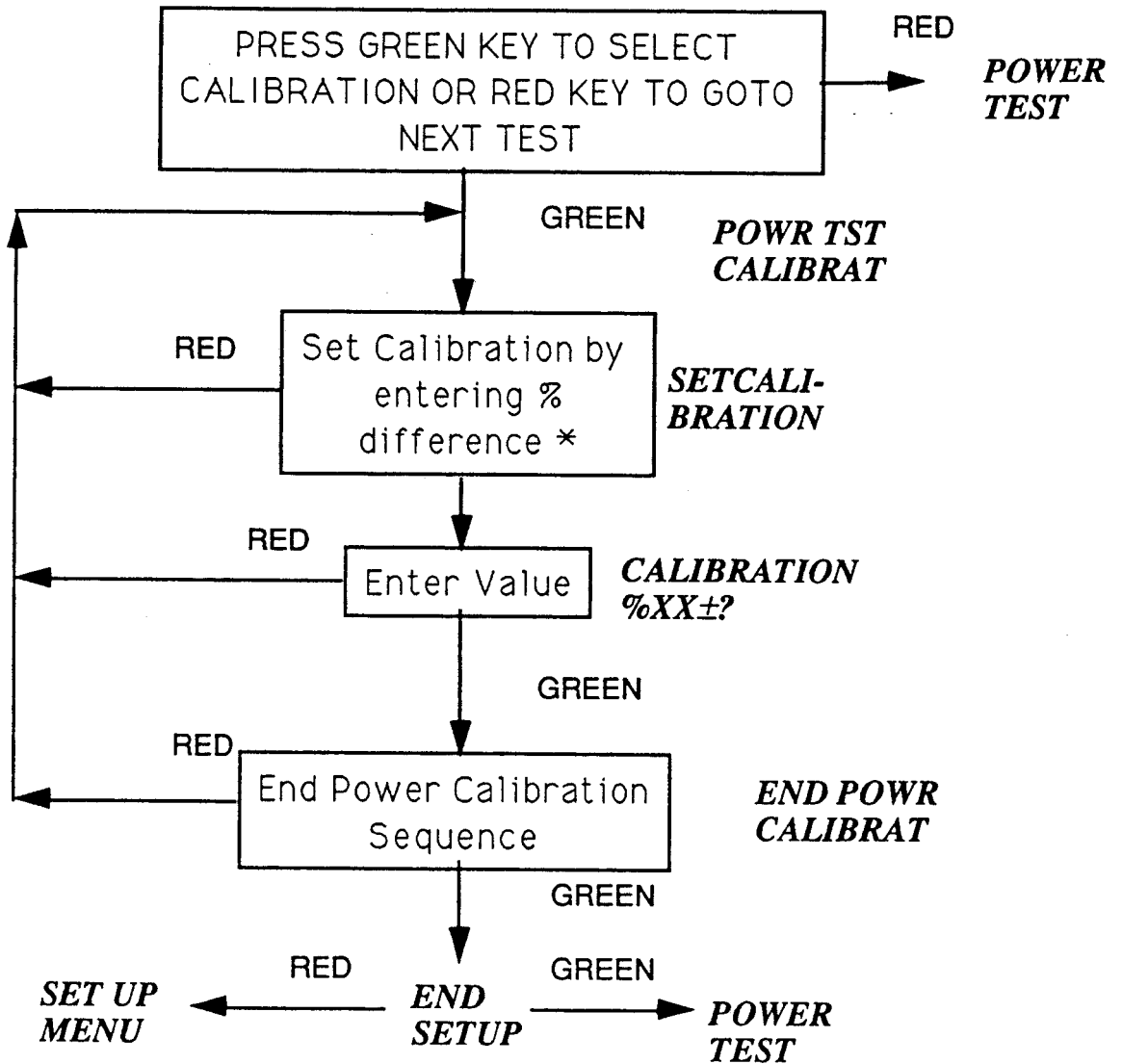
# GSM MOBILE AUTO TEST PROCEDURES

## 2.Initial Test Parameters



# GSM MOBILE AUTO TEST PROCEDURES

## 3. Power Test Calibration



\*

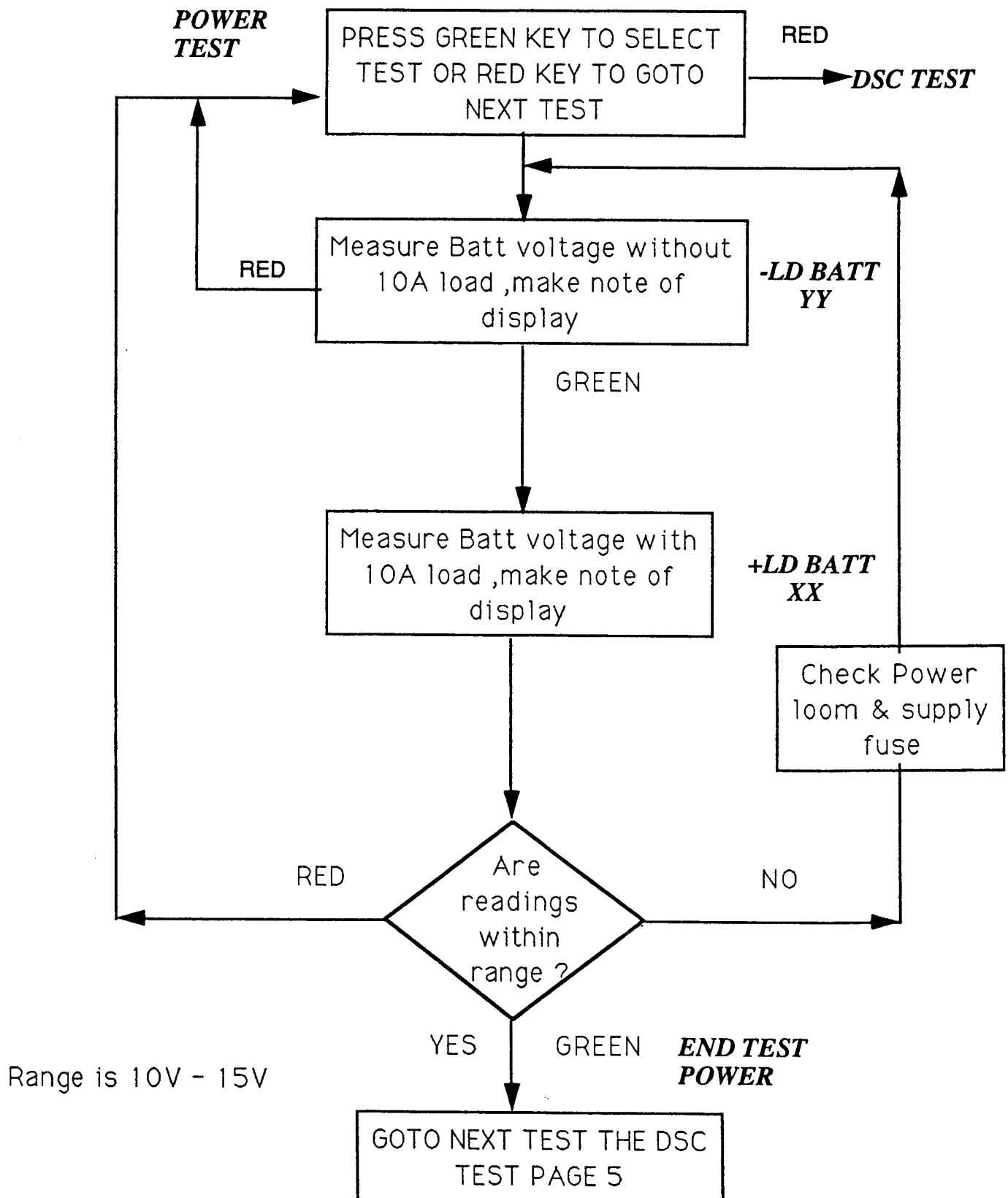
$$\% \text{ Value} = \frac{\text{H/S Value} - \text{DVM reading}}{\text{H/S Value}} \times 100$$

If a +ve % is to be entered enter value and then \* for +ve  
 If a -ve % is to be entered enter value and then # for -ve

To do this test first of all measure the vehicle battery terminal voltage using a DVM. Then goto test 4. Power Test and make a note of the off load voltage. Then put these figures into the above formula to obtain the calibration value to enter when doing the above sequence.

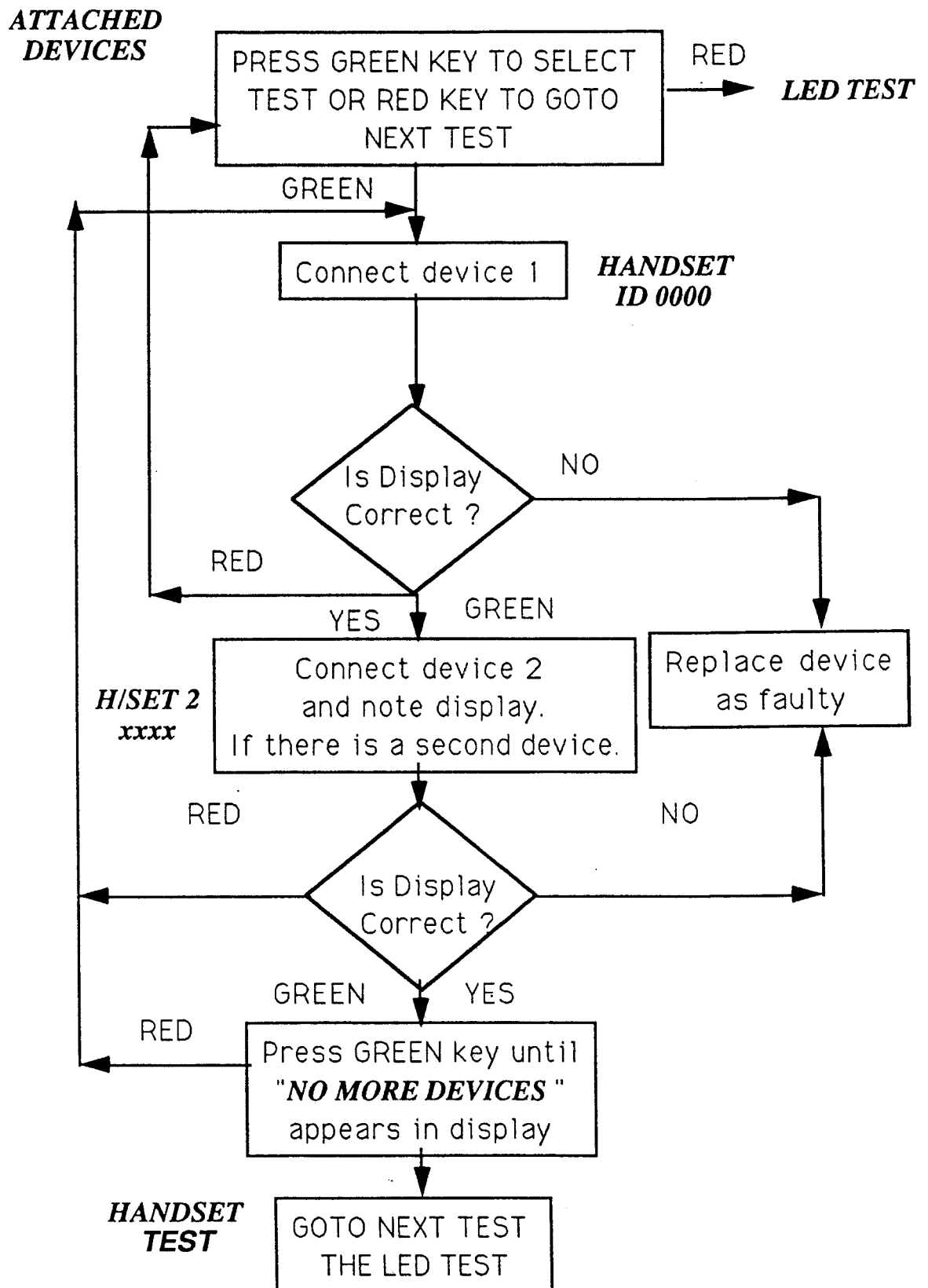
# GSM MOBILE AUTO TEST PROCEDURES

## 4 Power Test



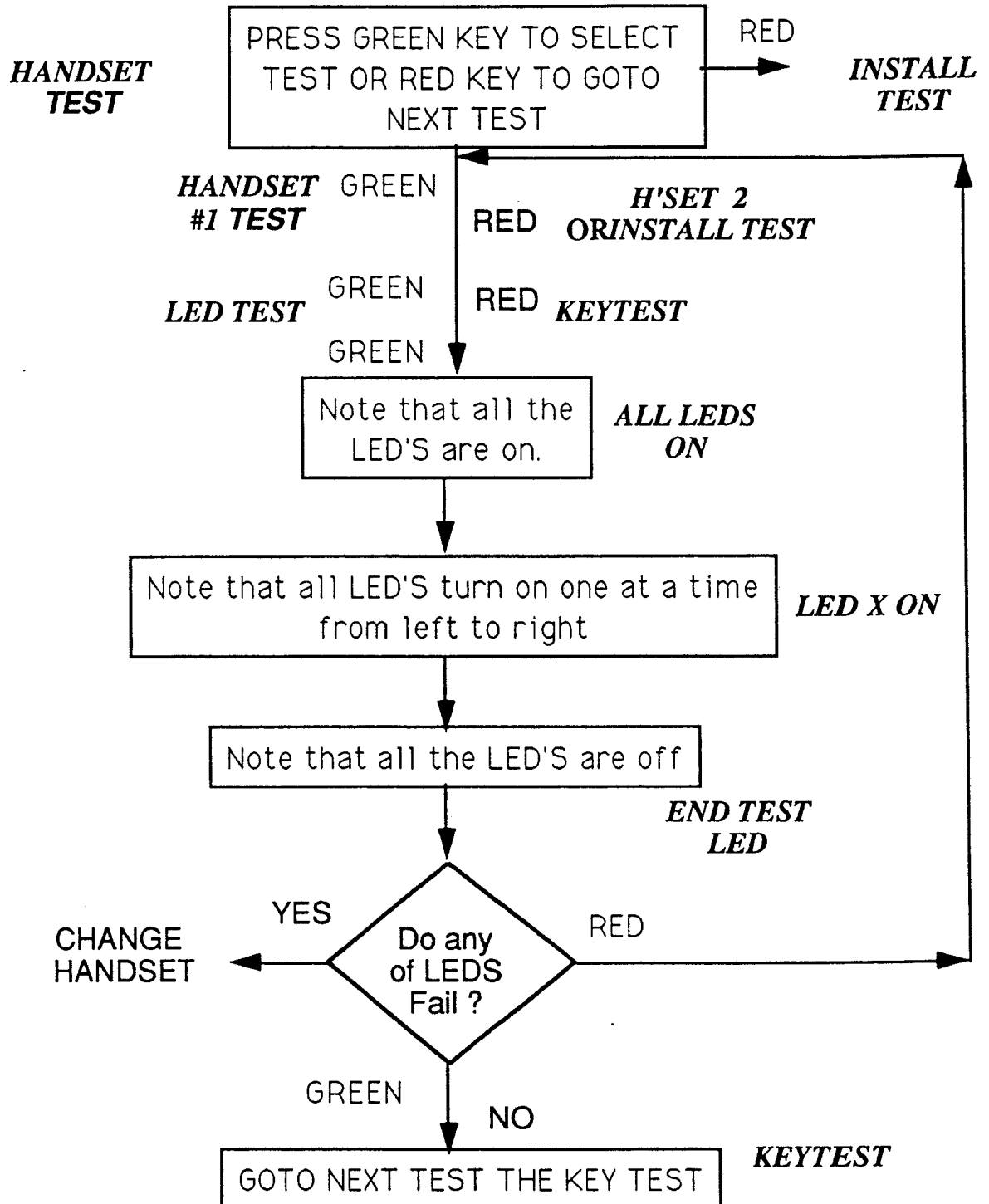
# GSM MOBILE AUTO TEST PROCEDURES

## 5.DSC Test (Data Speech Control)



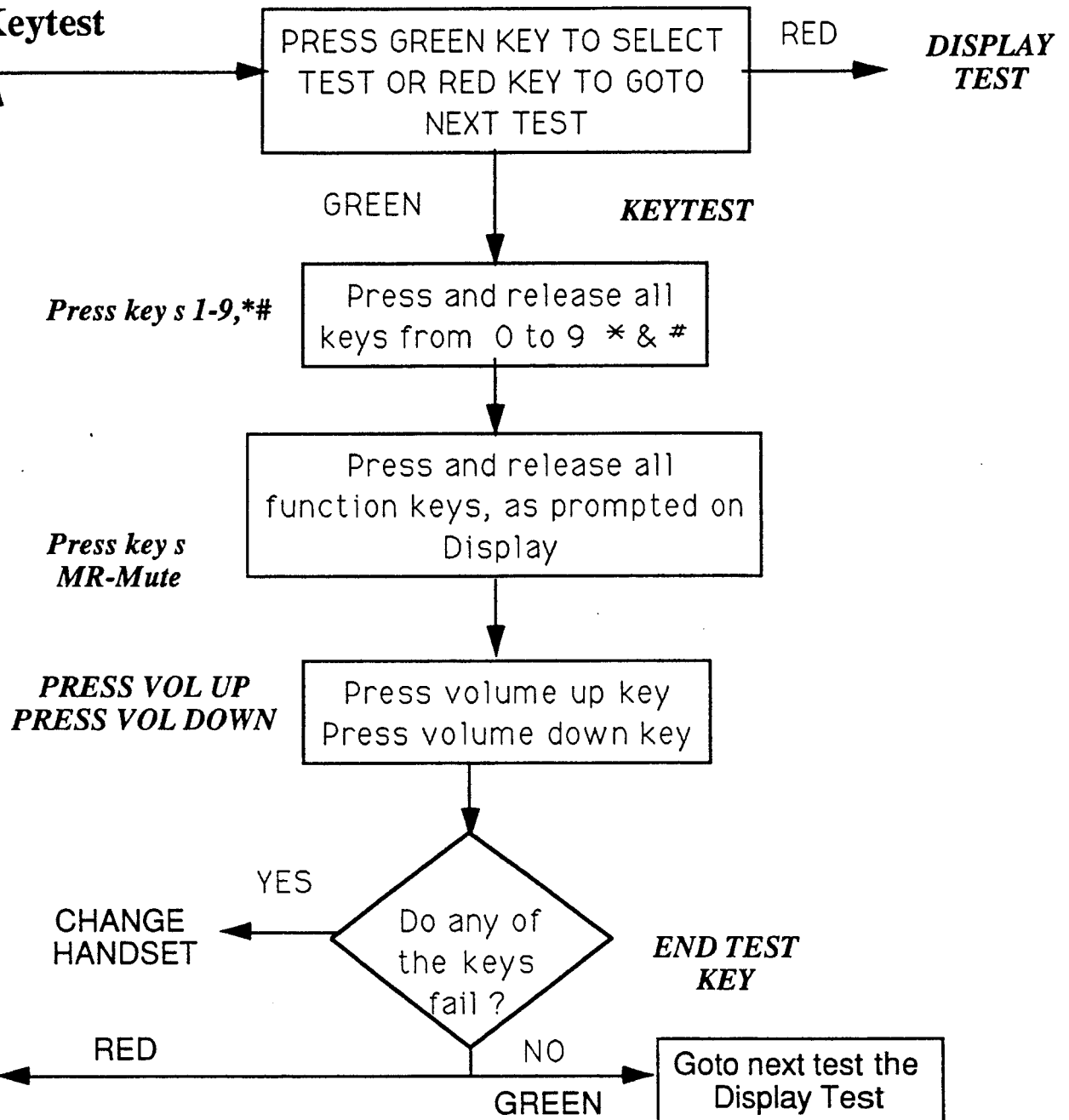
# GSM MOBILE AUTO TEST PROCEDURES

## 6 Handset Test Status LED Test



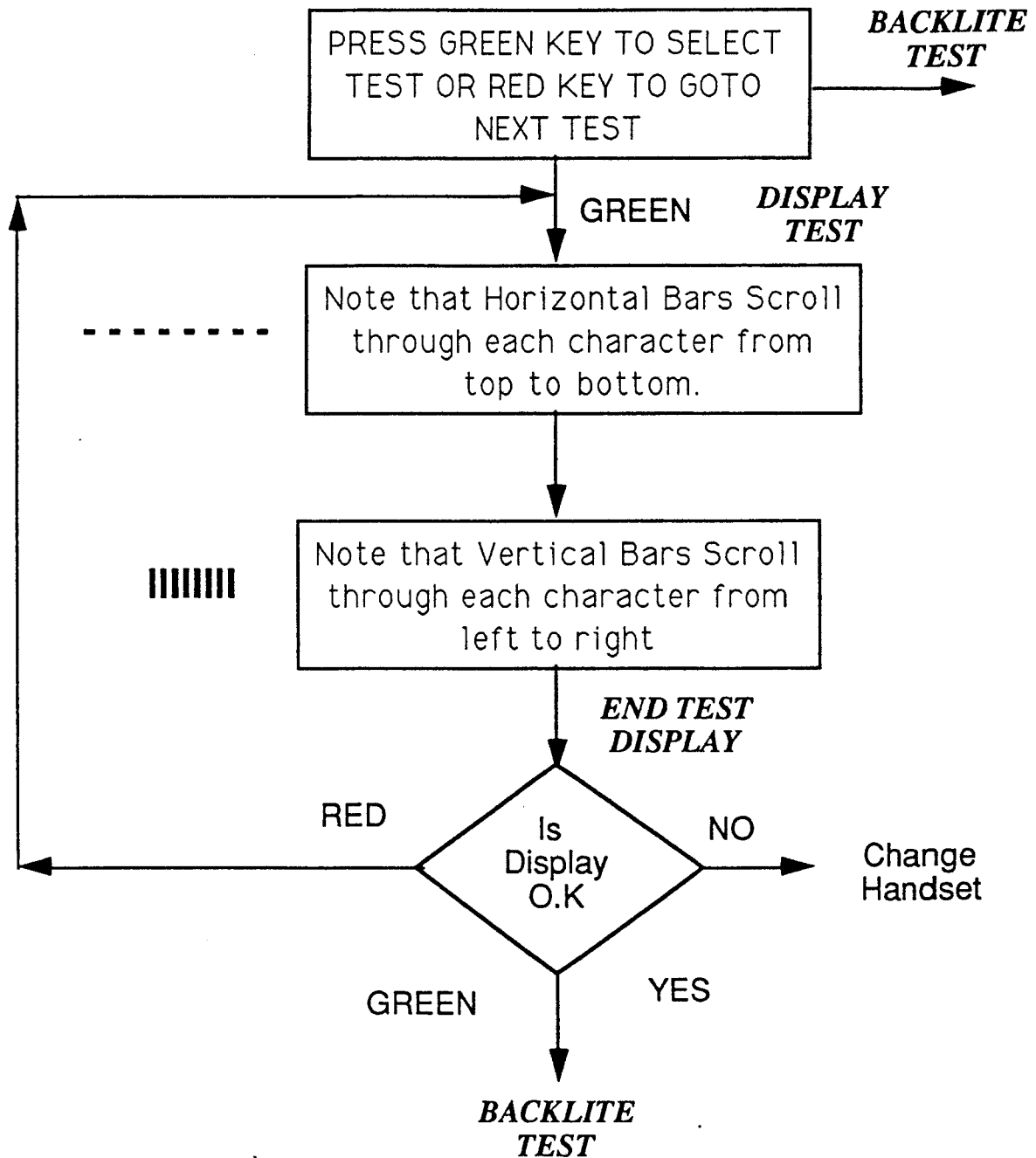
# GSM MOBILE AUTO TEST PROCEDURES

## 7 Handset Keytest



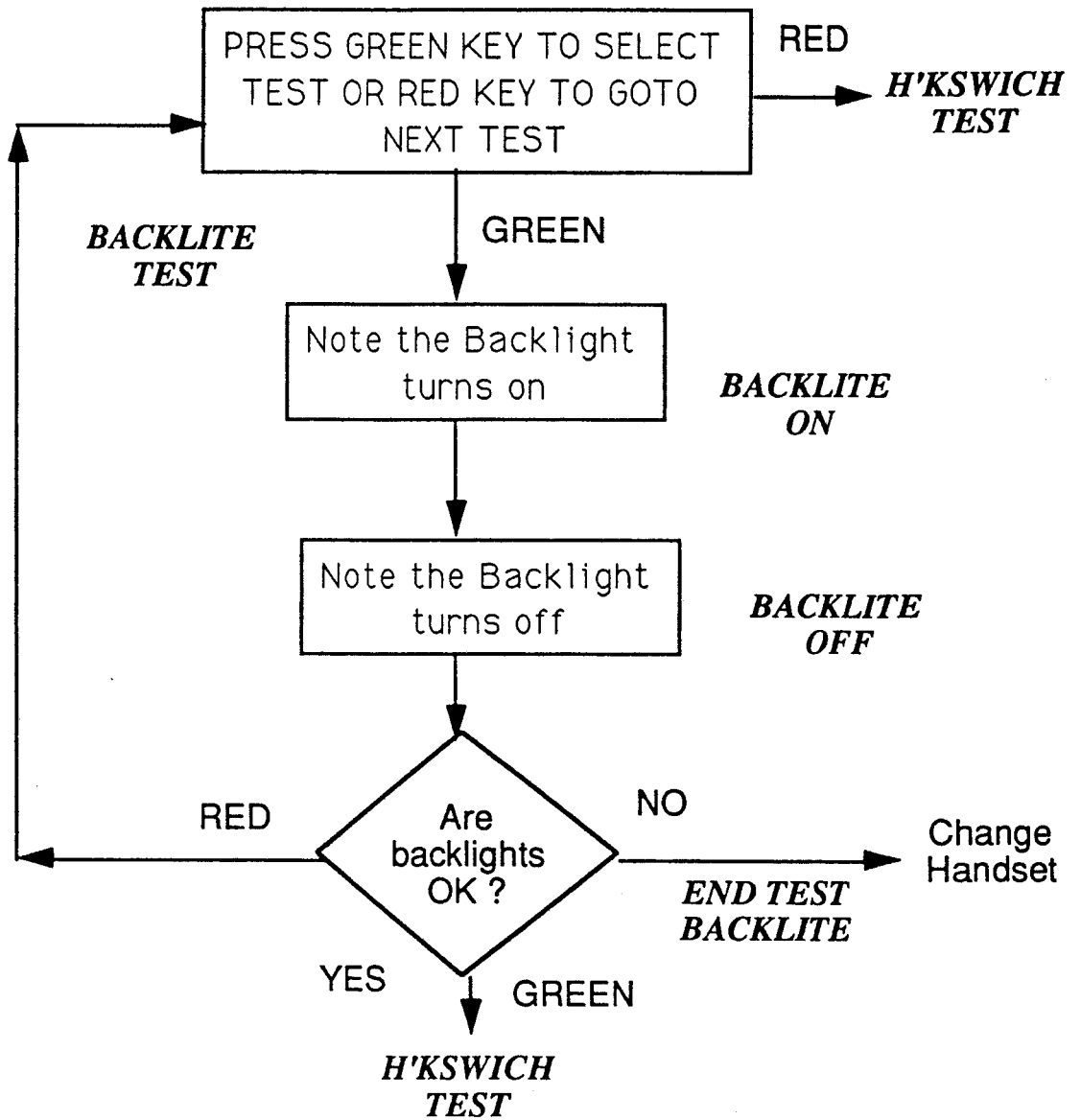
# GSM MOBILE AUTO TEST PROCEDURES

## 8. Display Test



# GSM MOBILE AUTO TEST PROCEDURES

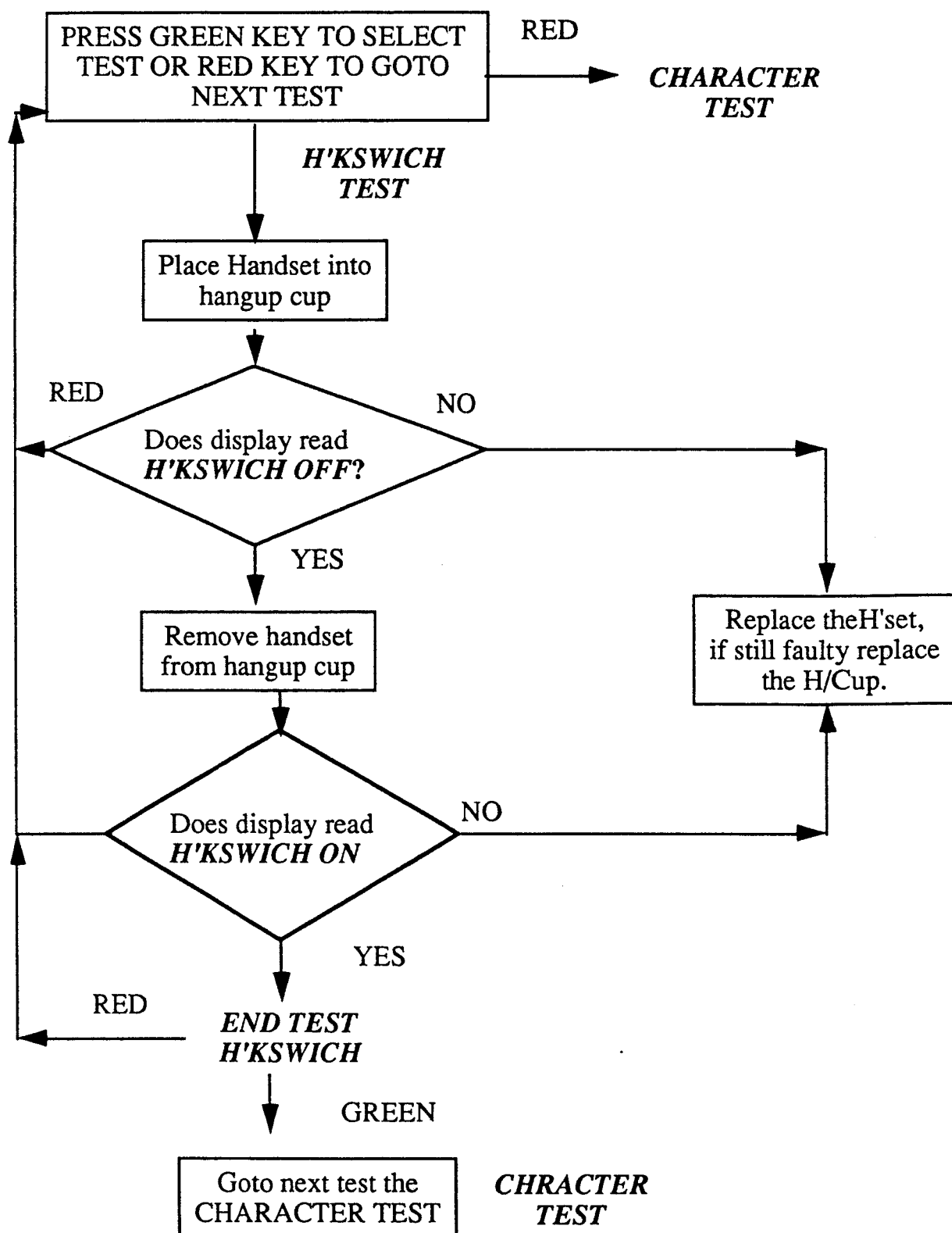
## 9. BackLight Test





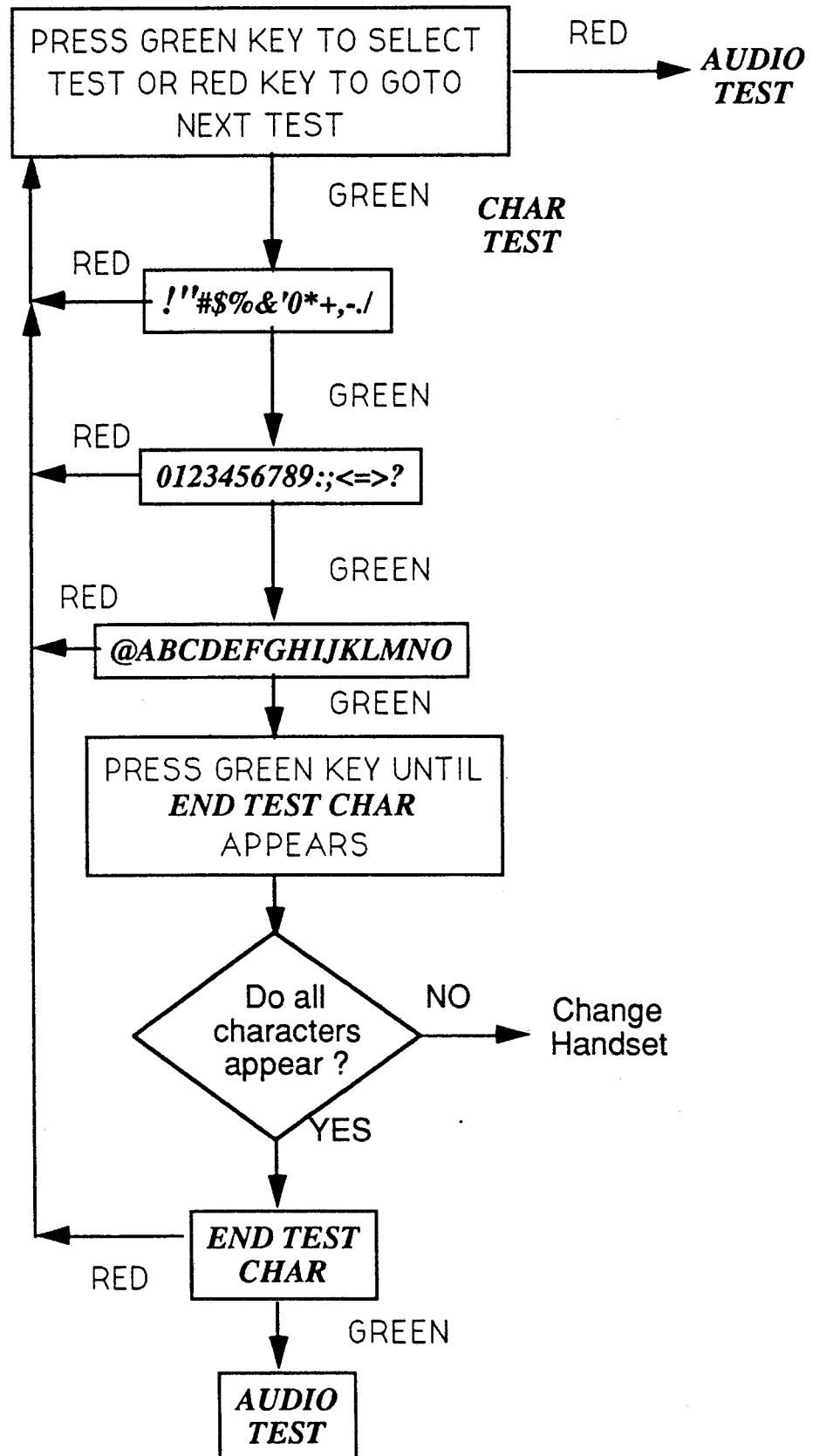
## 10.Handset Hookswitch Test

# GSM MOBILE AUTO TEST PROCEDURES



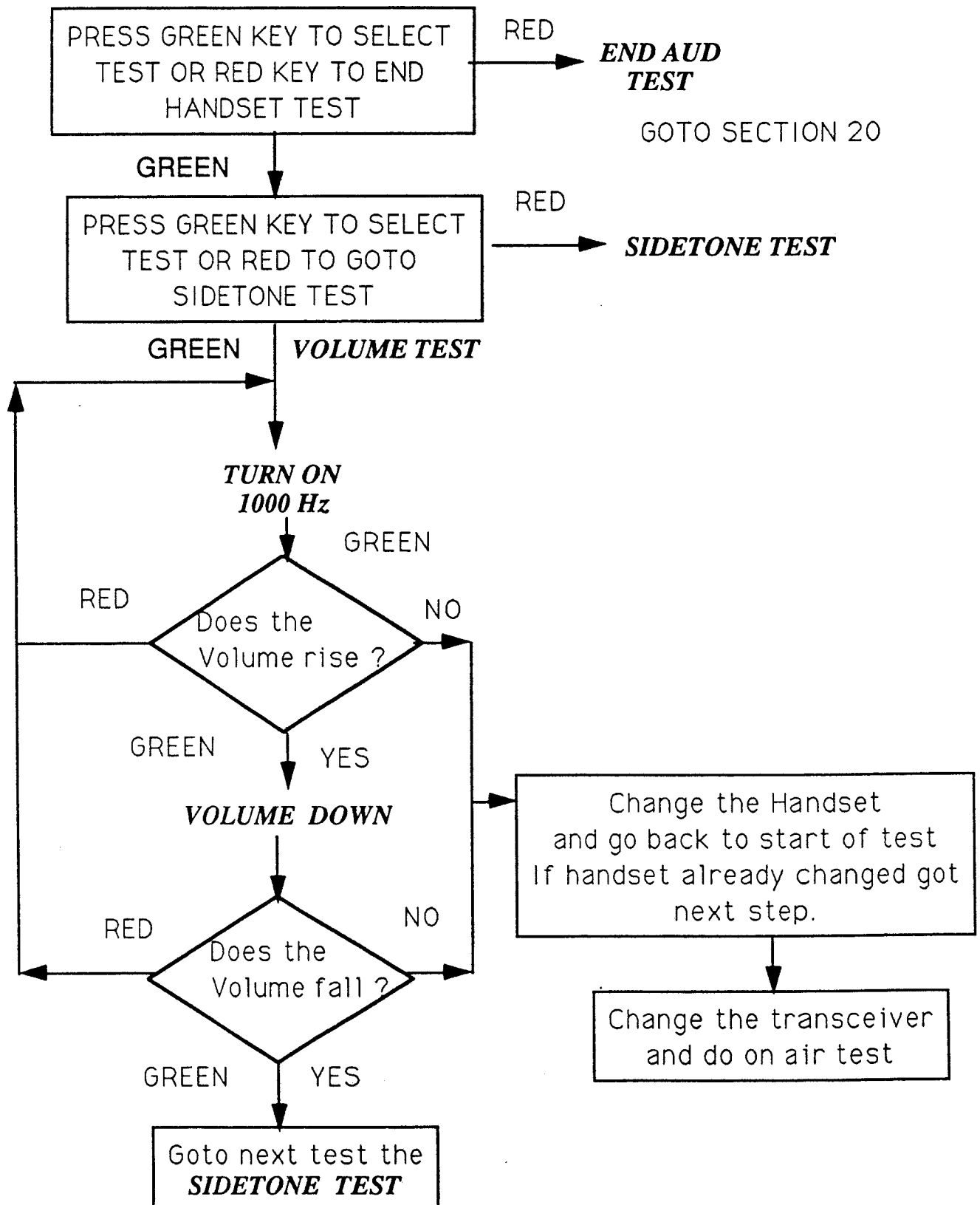
# GSM MOBILE AUTO TEST PROCEDURES

## 11.Character Test



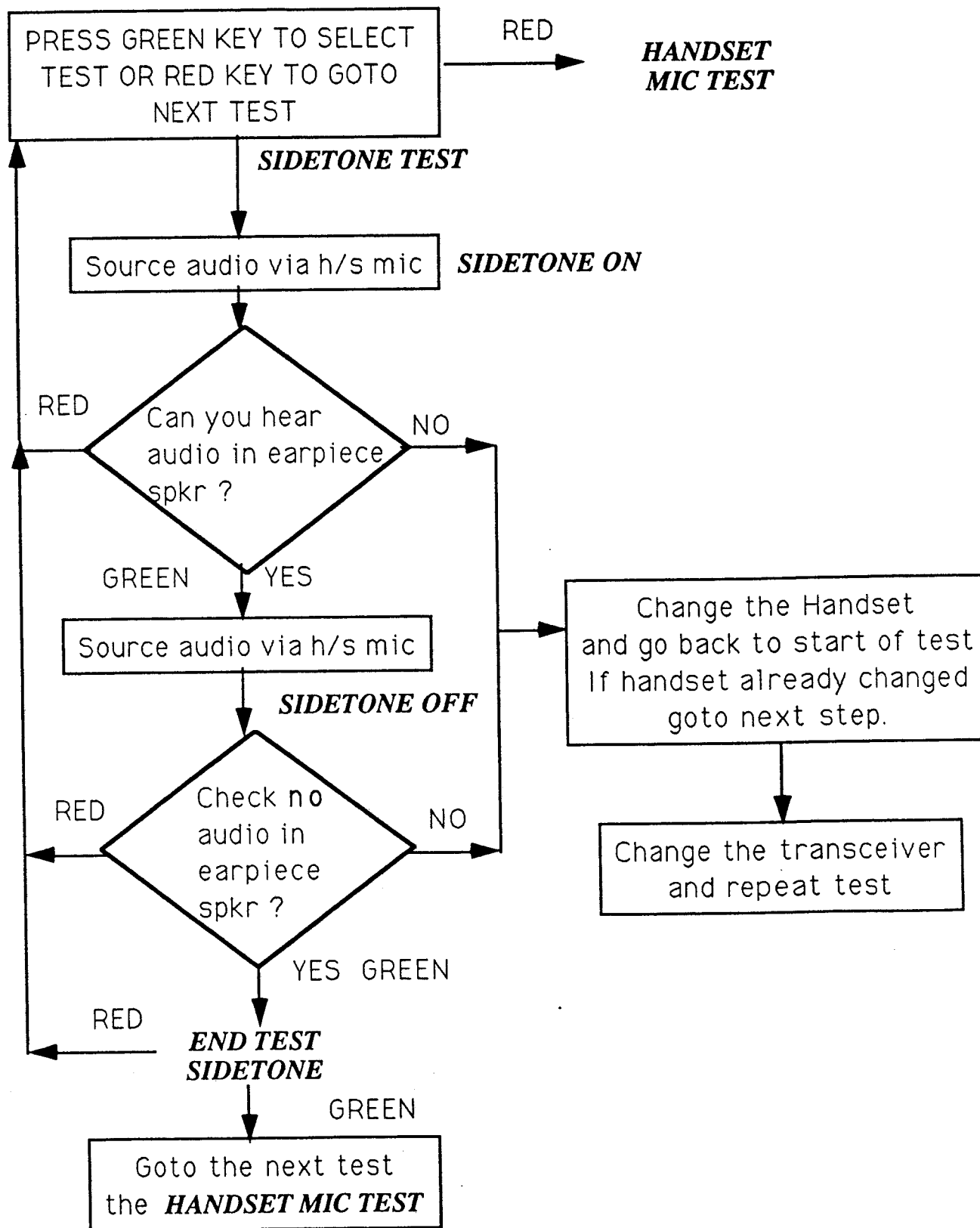
# GSM MOBILE AUTO TEST PROCEDURES

## 12. Handset Volume Test



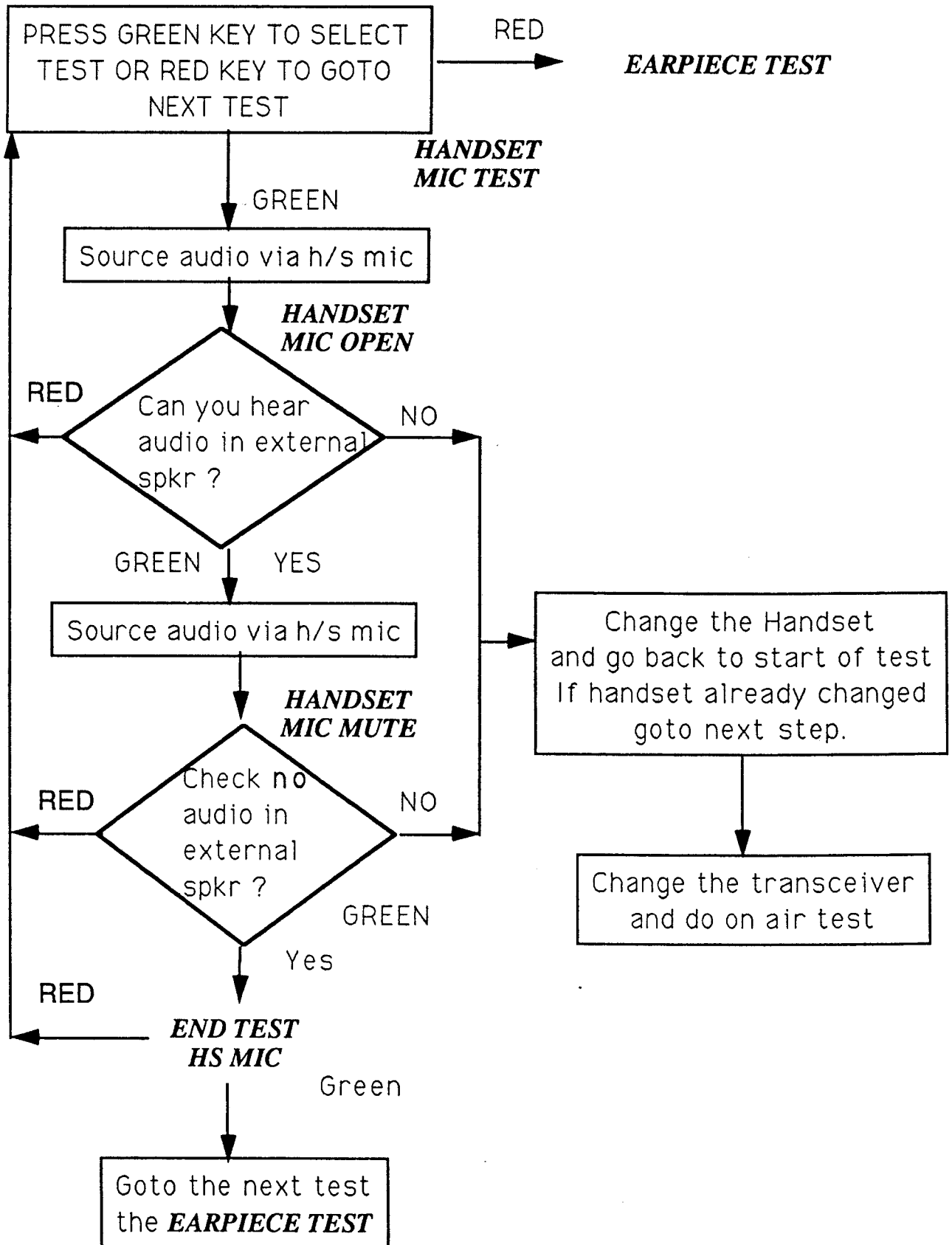
### 13. Handset Sidetone Test

## GSM MOBILE AUTO TEST PROCEDURES



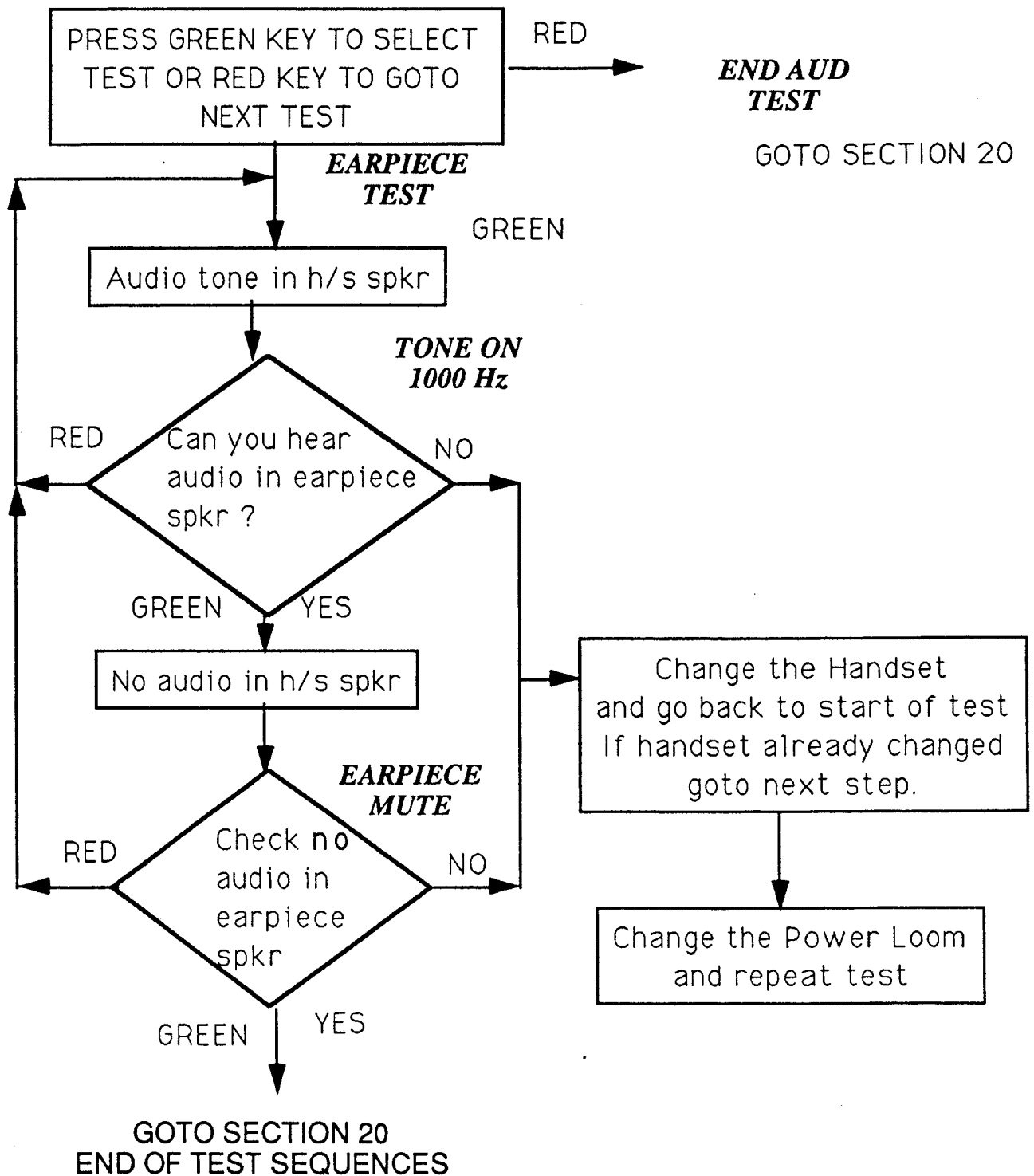
# GSM MOBILE AUTO TEST PROCEDURES

## 14 Handset Mic Test



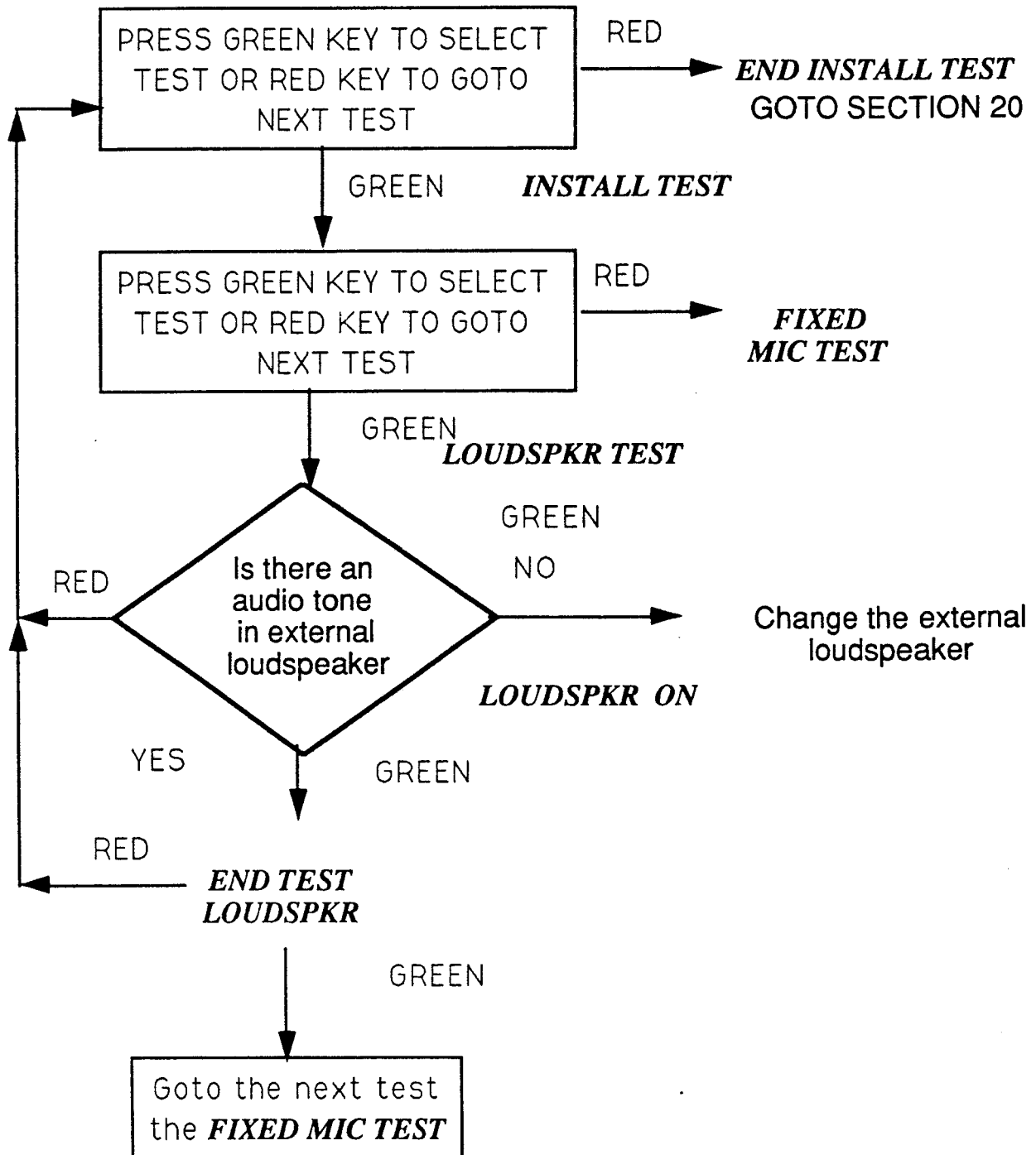
# GSM MOBILE AUTO TEST PROCEDURES

## 15 Handset Earpiece Test



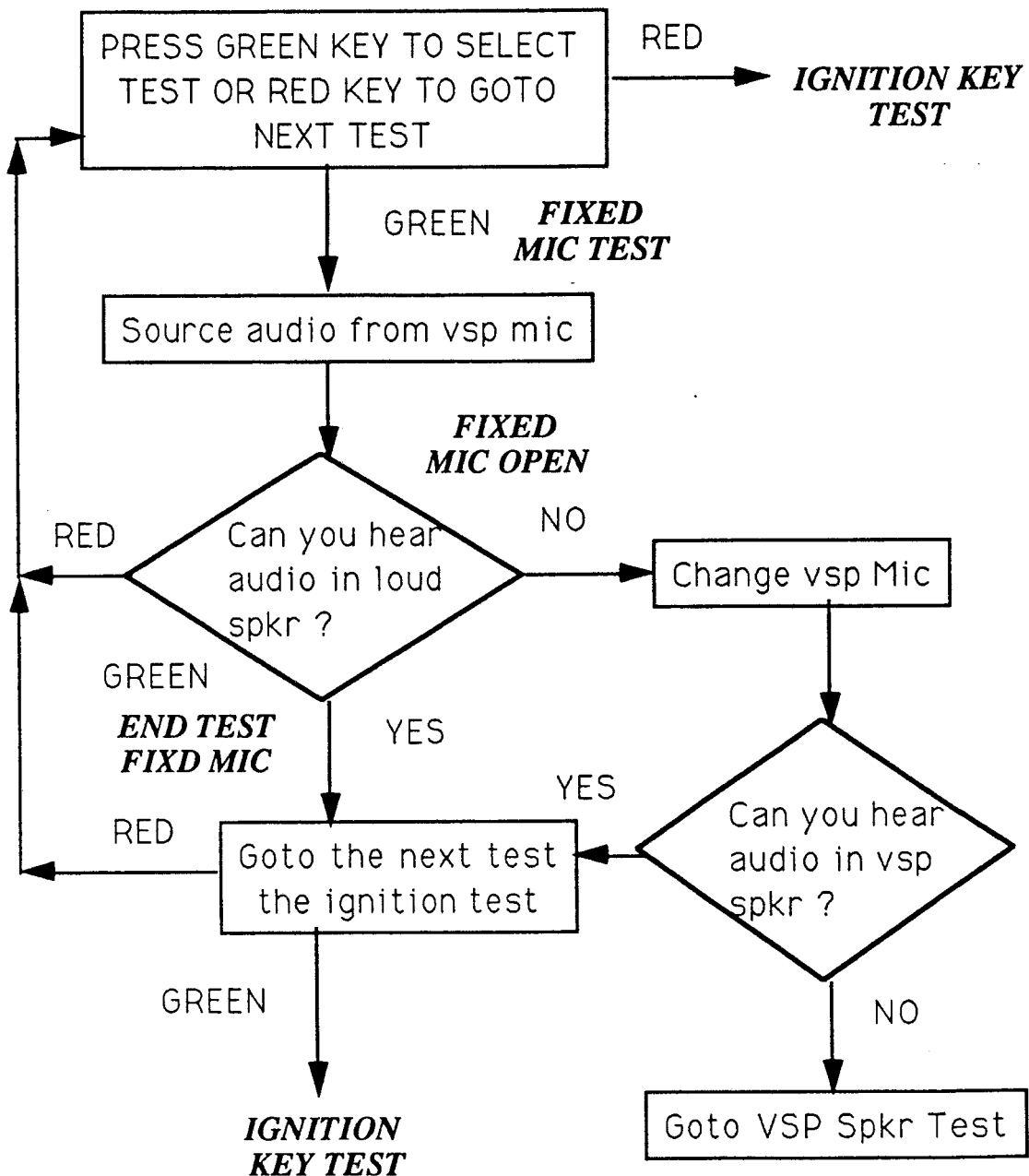
# GSM MOBILE AUTO TEST PROCEDURES

## 16 VSP Speaker Test



# GSM MOBILE AUTO TEST PROCEDURES

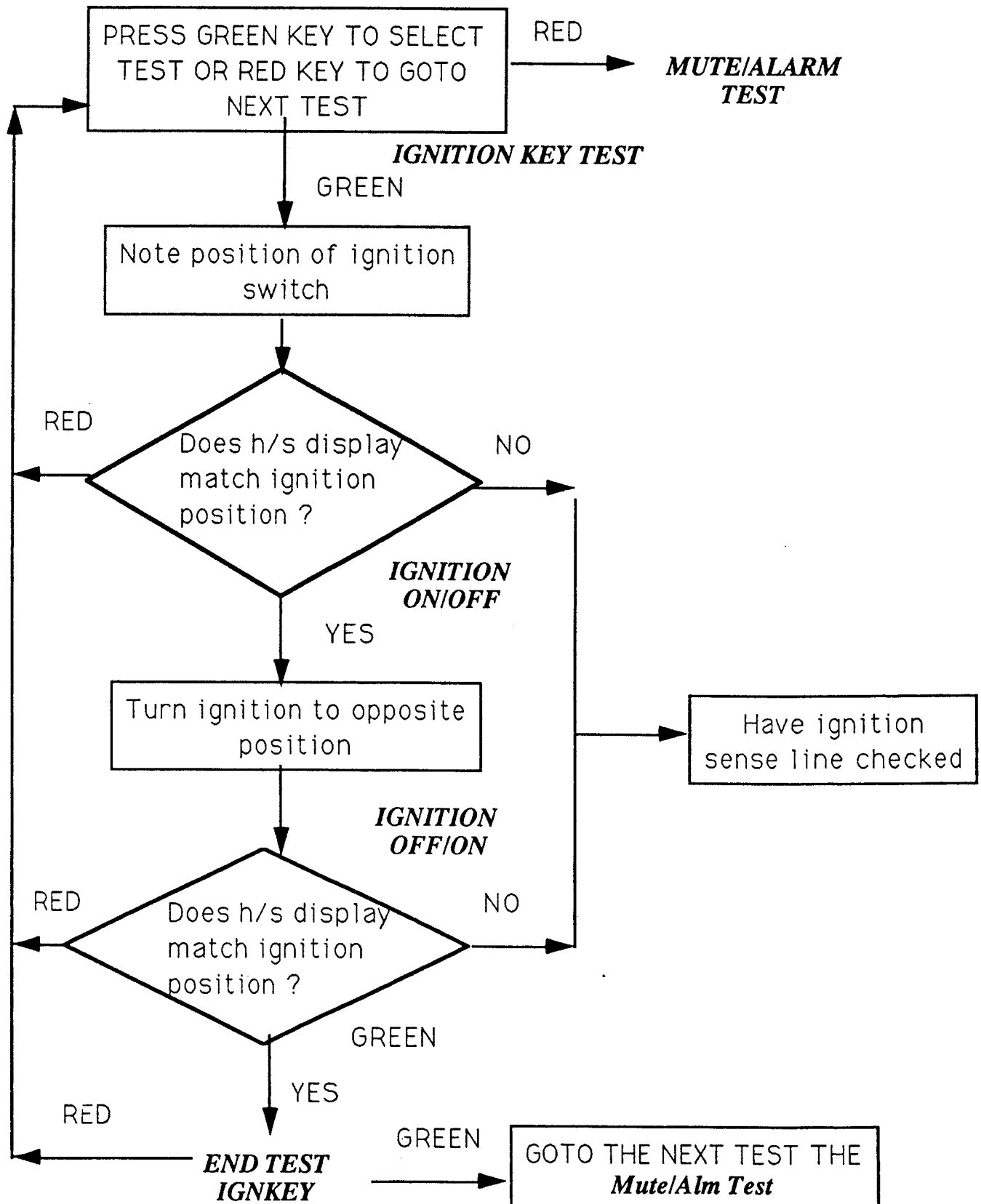
## 17 Fixed Mic Test





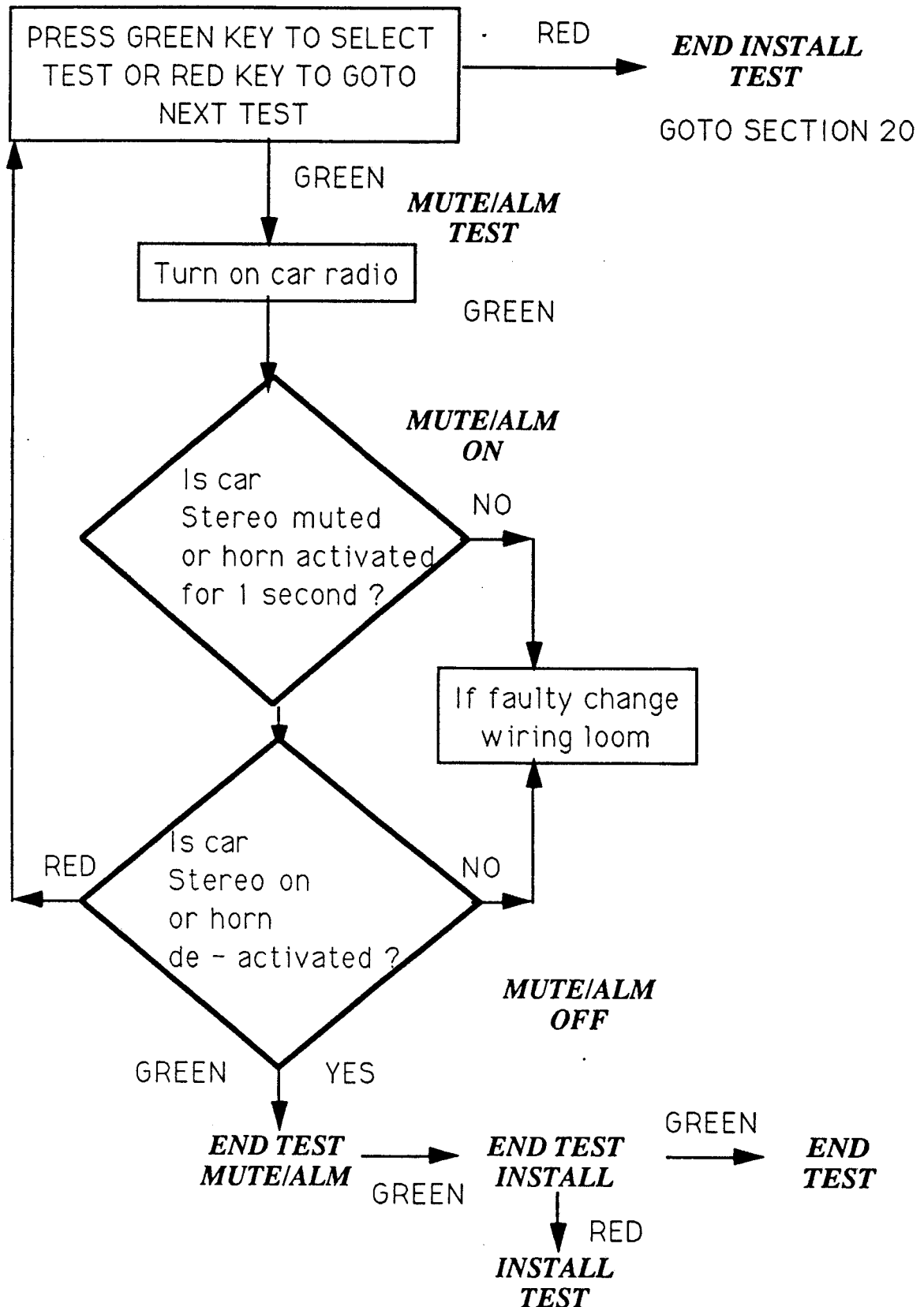
# GSM MOBILE AUTO TEST PROCEDURES

## 18 Ignition Test



# GSM MOBILE AUTO TEST PROCEDURES

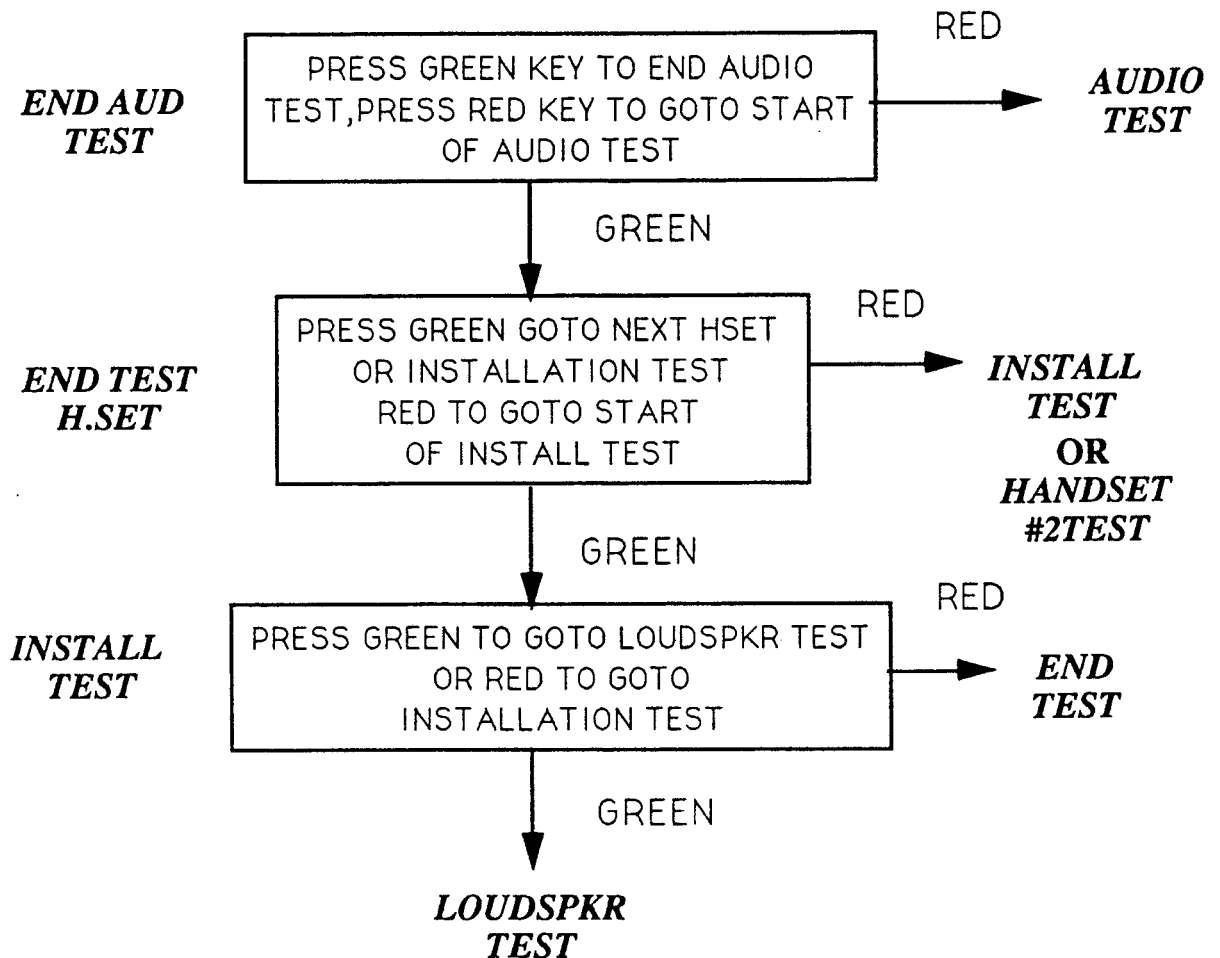
## 19 Mute/Alarm Test



This feature is not available on Pre-Commercial product and so this test may not work if yellow/black wire is not connected on the power loom.

# GSM MOBILE AUTO TEST PROCEDURES

## 20. End of Test Sequences



### DSC BUS ERROR POSSIBLE PROMPTS

If unknown device is connected possible prompt is

**UNKNOWN ID**

**0800**

If there is an error in the DSC bus telegram concerning key data the following prompt may appear

**DSC KEY**

**ERROR 00C0**

If there is an error the DSC bus telegram concerning hook-switch data the following prompt may appear

**DSC HOOK**

**ERROR 04**

# **SERVICING THE CUSTOMERS GSM PHONE**

# **7.SERVICING THE GSM MOBILE**

## **Contents:-**

- \* Introduction**
- \* Mobile System Description**
- \* Transportable System Description**
- \* Transportable Battery Maintenance**
- \* Transceiver Disassembly/Assembly**
- \* Handset Disassembly/Assembly**

# **Servicing the GSM Mobile**

## **7. Introduction**

Fig 1 shows the complete Pre-Commercial GSM Mobile system broken down into its main components. Listed below is a brief description of each component in the system and its purpose.

### **7.1 Mobile Transceiver**

The GSM Mobile Transceiver is a microprocessor controlled, full duplex, digital radiotelephone, operating around the 950 MHz frequency range. There will be two versions of the transceiver one operating at 8 Watts and the other at 20 Watts, RF output power.

This is the main part of the mobile system and controls the operation of the surrounding components, ie handset, VSP mic etc.. The Mobile Transceiver contains three boards, a audio/logic board, a RF Board, these provide the interface to the air transmission specification and ultimately into the public landline telephone system. The third board is the Subscriber Identity Module (SIM) card reader which enables the user to enter his/her unique International Mobile Subscriber Identity (IMSI) code into the transceiver using his/her SIM card, which enables the customer to access the system to make and receive calls.

#### **7.1.1 Handset**

The handset consists of three main parts, one Printed Circuit Board (PCB), a keypad and a coil cord.

The PCB contains circuitry which supports the transmit and receive audio, from the handset microphone and speaker, it also controls the operation of the keypad.

The keypad enables the customer to enter telephone numbers into the Mobile system enabling the system to connect the customer to a land line number. The keypad is also used by the customer to enable/disable special features within the Mobile system i.e Mute Handset Microphone.

All of the above components of the handset connect to the transceiver via the coil cord. The handset unit is the interface between the customer and his/her GSM Mobile phone. It enables the customer to place a call and to answer an incoming call using the keypad on the front of the handset.

# **Servicing the GSM Mobile**

## **7.1.2 Power Loom**

This connects all of the GSM Mobile system components together and also provides the connection to the battery power supply and to the ignition sense source. The connection to the Mobile transceiver is provided by a D-Type connector, the Handsfree speaker and Microphone are connected via two 'Molex connectors', which cannot be connected the wrong way around. The Handset connects into the Power Loom via an 8 pin socket. The power supply lines are wires which can have the appropriate connector fitted and connected to the car battery supply.

( See Section 4 Installation )

## **7.1.3 External Speaker**

Audio will be generated from this speaker for the following audio signals:-

- a) Incoming ringing tone
- b) Keypad tones
- c) Handsfree incoming audio

The speaker consists of a standard speaker, a metal housing and a length of cable with a molex connector on the end for connecting to the power loom.

## **7.1.4 Handsfree Microphone**

This is a microphone used when the mobile phone is in handsfree mode, it takes the transmit audio and routes it through to the mobile. The microphone simply consists of a cartridge mic, a pre-amp circuit, a plastic housing and a length of cable with a molex connector on the end for connecting to the power loom.

# **Servicing the GSM Mobile**

## **7.1.5 Handset Hang-up cup**

This device is used to hold the handset when not in use and it operates with the handset by the use of a magnet to activate the following features:-

- a) To answer calls when the handset is removed from the hang-up cup.
- b) To end calls when the handset is placed back into the hangup cup.
- c) To switch between handsfree and handset operation during a telephone call.  
( Handsfree not available on Pre-Commercial Product).

The hang-up cup is made up of a plastic shell, magnet and some mechanics which allow easy release of the handset from the hang-up cup.

## **7.1.6 Installation Hardware**

This package contains the hardware necessary to connect the power loom to the battery supply i.e Fuses and connectors, to install the hang-up cup and handsfree microphone. The installation hardware for the handsfree microphone and the hang-up cup is a mounting bracket in both cases.

There is also a mounting bracket for the Mobile Transceiver which is a plastic style tray which is attached to a suitable surface and the mobile slides onto the mounting bracket.  
(See Section 4 Installation )



## GSM Transportable System



Fig 2

## Servicing the GSM Mobile

### 7.2 Transportable

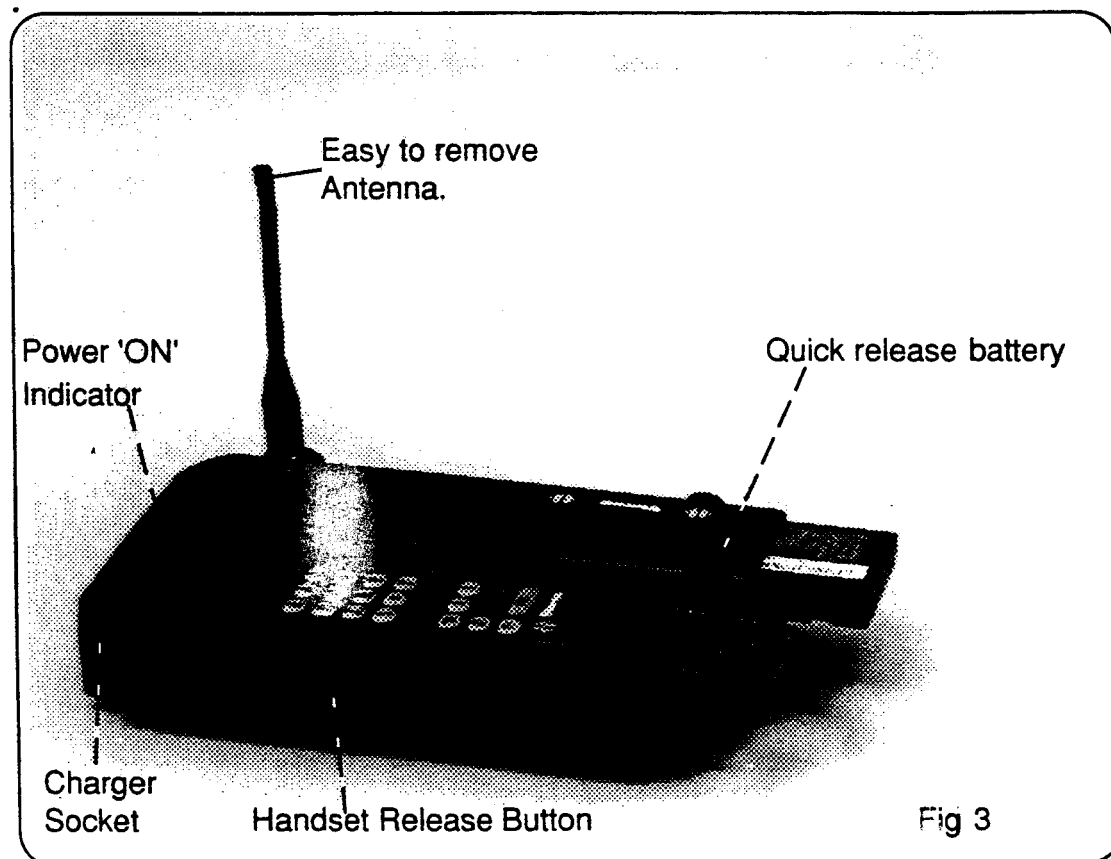
The Transportable accessory pack allows the GSM mobile to be converted into a portable phone making for easy use in the Office, building site etc..

The complete transportable system is shown in Fig 2, it contains the following components;

1. Battery	SNN4067A
2. Antenna	SAF4300A
3. Carger Mains slow	SPN4055A
4. Transceiver	SUF1331A
5. Transportable housing	CCLN2123B
6. Cigarrete lighter adapter	SLN8003A
7. AC power supply	CCPN4013A
8. Handset	SCN2487A

The Transportable accessory pack has the following features; see Fig 3

- \* Quick release Battery
- \* Quick release Antenna
- \* Power 'ON' indicator
- \* Easy to release transceiver mechanism
- \* Handsfree capability
- \* Easy to use charger
- \* In car charging capability
- \* Capability to operate direct from mains



# Servicing the GSM Mobile

## 7.2.1 Battery Maintenance

The Transportable contains a single sealed lead acid battery which provides power for the GSM mobile phone.

## **! WARNING !**

Sealed liquid electrolyte (lead Acid) battery should always be operated, stored, and charged in a well ventalated area. Lead-Acid batteries must never be stored or operated in an airtight container. To avoid damage to the batteries, never create a short circuit across the battery terminals. Do not dispose of the batteries in fire. Do not puncture batteries.

## 7.2.2 Battery Charging

### General

The transportable battery may be charged either from the mains using charger SPN4055A or from the cigarette adaptor , both chargers connect into the transportable using charging connector shown in Fig 3.

There is also available as an extra a AC spare battery charger SPN4064A which will recharge the battery when the battery has been removed from the Transportable housing

## 7.2.3 Vehicle Cigarette Lighter Charger

The cigarette lighter adapter connects into the cigar lighter in the car, the kit is supplied with a set of 'O' rings to adjust the diameter of the cigar lighter adaptor to ensure a tight fit. The time it takes to charge the transportable battery will variey from vehicle to vehicle, due to different voltage outputs from the cigarette lighter adaptor in different vehicles. However it should typically take 7 to 8 hours with the phone turned off and the vehicle engine running.

## 7.2.4 AC Chargers

The AC Charger SPN4055A connects into the transportable at charger connector shown in Fig 3 It will take approxiametly 8 hours to fully charge the battery from it being completely discharged. Do not switch the phone on during charging.

The Spare Battery charger SPN4064A connects directly to the battery unlike the chargers described above. To use this charger remove the battery from the transportable housing, as shown Fig 3. Then connect battery to the clip on the charger output lead, this usually takes 4 hours to charge the battery from flat.

## Serviceing the GSM Mobile

### ! IMPORTANT !

Do Not allow the battery to continuously charge for more than 2 days

### ! CAUTION !

Serious damage to the battery may result if it is charged to 14V DC or higher. Use of a Motorola constant Voltage charger is highly recommended.

### **7.2.5 AC Power Supply**

There is also available a mains Power Supply (SPN4064A) which enables the transportable to operate direct from the mains and therefore saves battery life. The Power Supply will not charge the battery and indeed the battery may be removed from the Transportable housing.

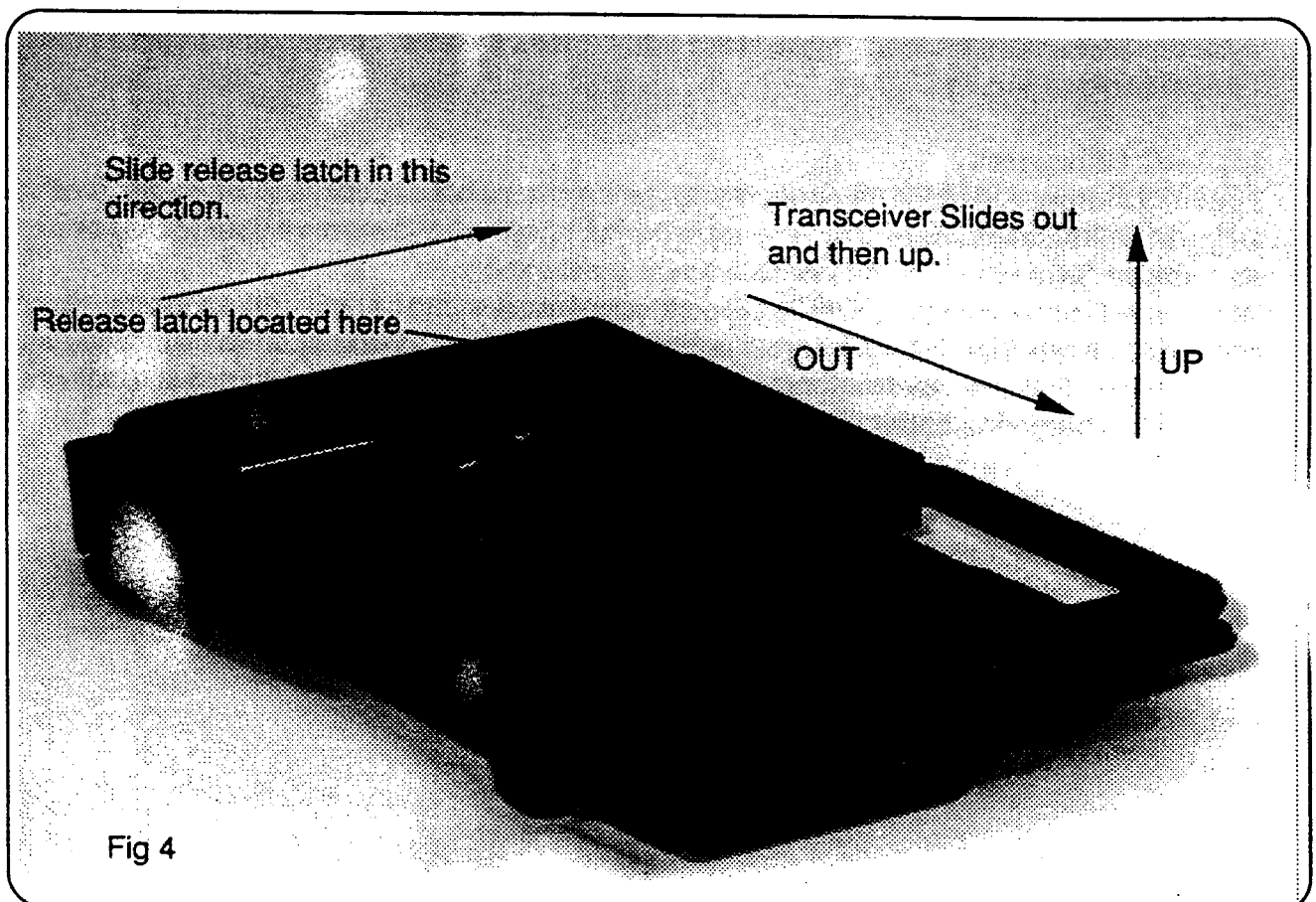
## **7.3 Transceiver, Handset and Battery Installation/Removal**

### **7.3.1 Battery Removal/Installation**

To remove the Battery from the Transportable housing lift the latch as shown in Fig 3. The Battery will then slide outwards and can simply be removed.

To install battery simply slide battery into Transportable housing until it clicks into place, the Battery will only slide in correctly in one position.

### **7.3.2 Transceiver Removal/Installation**



# **Servicing the GSM Mobile**

## **7.3.2 Transceiver Removal/Installation**

The Transceiver is removed from the Transportable housing by sliding the release latch and removing the Transceiver as shown in Fig 4. To install the Transceiver put it into the housing aligning the antenna connector on the Transceiver with the slot on the Transportable housing. Push the Transceiver down and then inwards so that the D-Type connectors fit together.

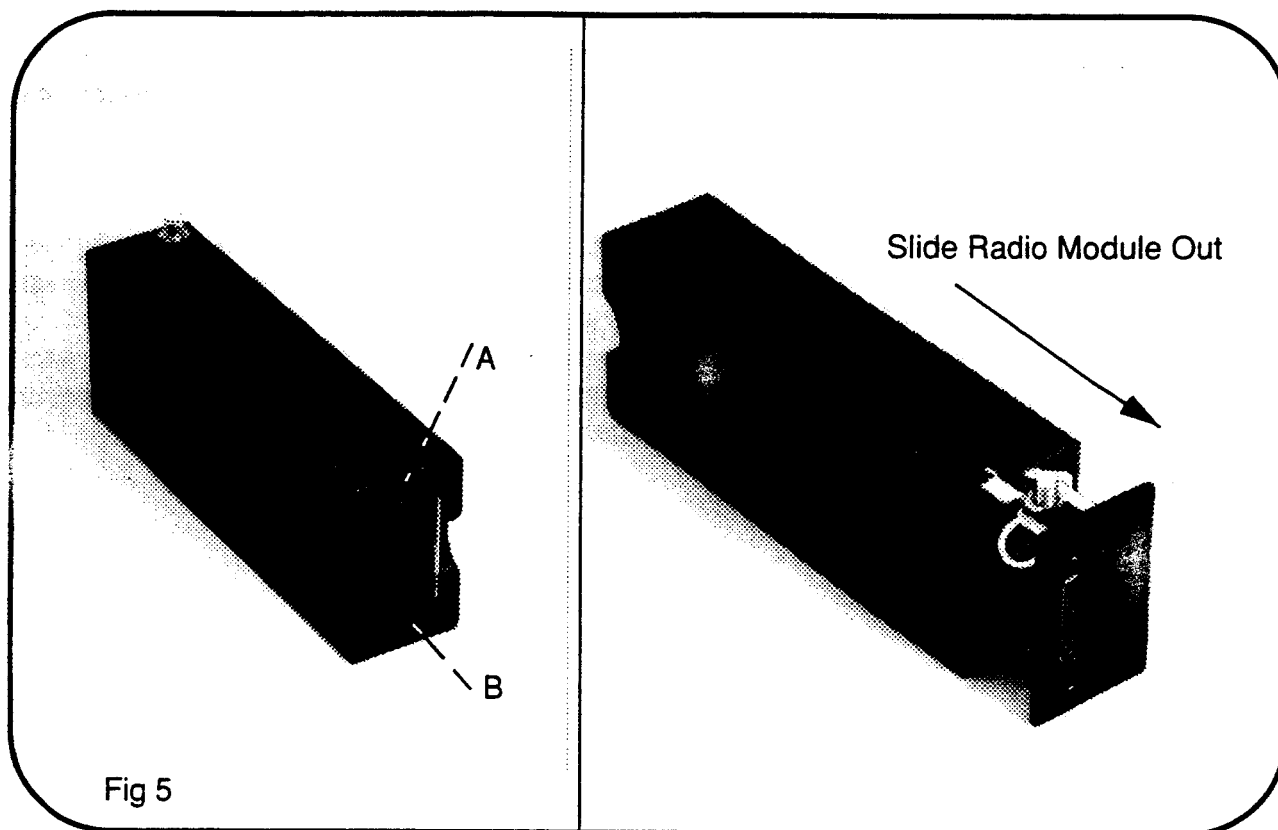
## **7.3.3 Handset removal/installation**

The handset is removed from the hangup cup by pressing the release button (see Fig 3) and lifting the handset up and away from the transportable. The coil cord is removed by pressing down the plastic clip on top of the coil cord plug and pulling plug out of socket.

To put the coil cord plug back into the Transportable socket, push the plug into socket ensuring the plastic clip lines up with socket in Transportable housing. The Handset simply clips back into the hangup cup when inserted.

## Servicing the GSM Mobile

### 7.4.1 Assembly/Disassembly of the Transceiver



#### **Disassembly**

The above diagrams in Fig 5 show how to take apart the GSM Mobile transceiver to change the radio module when it becomes faulty.

To take the radio apart take the following steps:-

- Simply undo screws A and B, this then releases the radio module inside the transceiver housing.
- Slide the radio module out as shown in Fig 5.

This radio module can now be packaged (anti-statically) and sent back for repair.

#### **Assembly**

To assemble the unit take the following steps:-

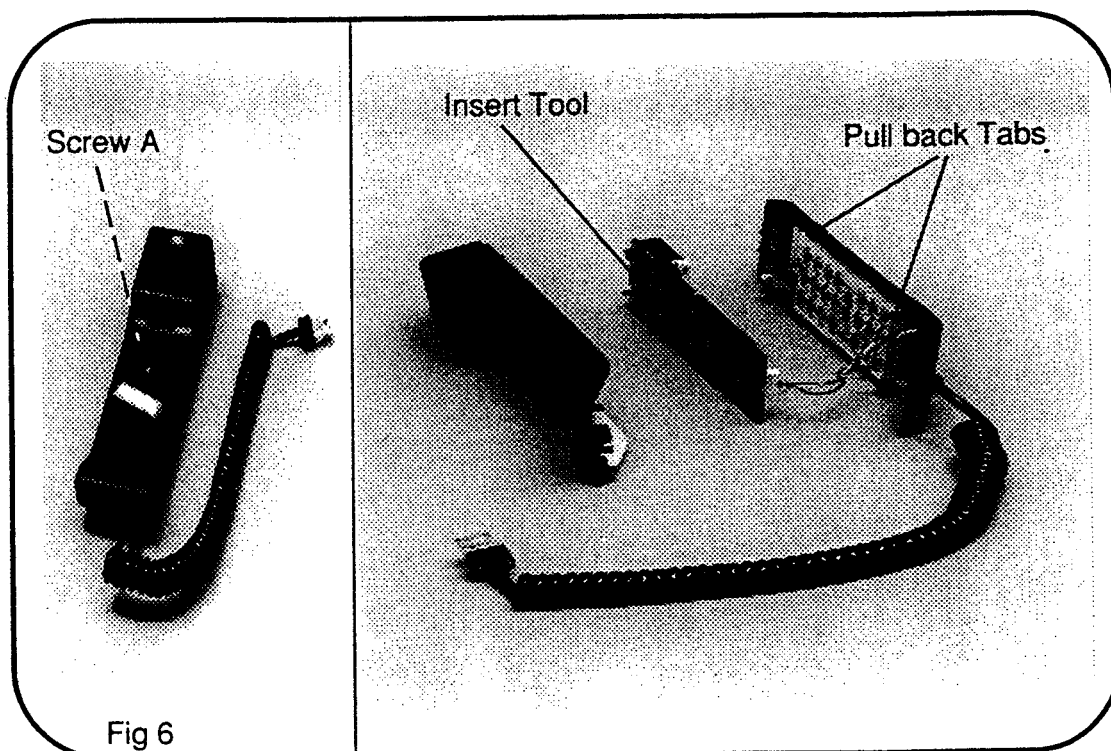
- Slide the radio module back into the transceiver housing.
- Screw back into place screws A and B.

#### **Note.**

It is only possible to slide the radio module into the transceiver housing in one position, due to the antenna connector stopping it going in incorrectly.

## Servicing the GSM Mobile

### 7.4.2. Handset Servicing



#### Disassembly of Handset

The disassembly of the handset to change a part is as follows:-

- Remove plastic cover on underside of handset, this exposes screw A.
- Undo screw A.
- To separate top and bottom housing of handset use a flat bladed tool and insert into top housing, as marked in Fig 6. Then lever housings apart taking care not to damage the housings. ( Use a plastic tool -NOT Metal).
- To remove the logic board from the top housing pull one tab (as shown in Fig 6 ) outward and pull logic board upwards and out of the tab, repeat this for all four tabs.
- The keypad if it needs to be removed simply comes away from the front housing by just pulling it off.

The display module cannot be changed and if needs replacing a complete logic board is required.

#### Assembly of Handset

To re-assemble the handset you need to follow the above steps in reverse. i.e 1. Put keypad back in. 2. Clip back into place the Audio logic board. 3. Put the top and bottom housings together, put coil cord end together first and then clip together display end of housings. 4. Replace Screw A and put plastic shield back on.

### **7.4.3 Personality Transfer using „Floppy SIM Card“.**

When a customer brings in his/her GSM Mobile or Portable for repair if the electronic board assembly needs to be replaced the replacement boards need to be set to the same set of features as the customers boards.

For the GSM Mobile and the Portable series there is available a process that will enable the Service Station to set a Service Mobile or Portable to the same feature set as the customers unit i.e call timers, charge rates and other user selectable features, e.g Silent Keypad and also transfer any telephone numbers the customer may have stored. This is known as a Normal Transfer.

The „Floppy SIM card“ can also be used to set a Service Radio to the correct feature set if the customers unit is „dead“ and a normal transfer is not possible. This is known as Master Transfer Procedure.

#### **Normal Transfer**

The process for setting the customers new electronic board assembly to the correct feature set and transferring any stored numbers is as follows ;

To transfer data from one radio to another the data must first be taken out of the source radio (customers radio), this is done by placing the customers data onto the „Floppy SIM Card“ . This data must then be loaded into the target radio (replacement radio), this is done by removing the „Floppy SIM card“ from the source radio and placing the „Floppy SIM card into the target radio.

The „Floppy SIM Card“ is not capable of transferring all the data from the source radio to the target radio in one transfer procedure, therefore two transfer operations are required to transfer all the data from one radio to another.

The actual sequence of events is as follows;

1. Insert the „Floppy SIM Card „ into the source radio, turn on the radio and the radio should read „Clone“.
2. The source radio is now in „Clonning mode“ and the radio is now ready to transfer its first section of data onto the „Floppy SIM Card“ this is done with the following command:-

021#

3. After the above command is entered „Please Wait“ will appear in the display. After a short period of time if the transfer to the „Floppy SIM Card“ was completed successfully „Clone“ will reappear in the display.



4. Now remove the „Floppy SIM Card“ from the source radio and place it in the Target radio and turn the phone on. The display should show „Clone“ the target radio is now ready to receive the data from the „Floppy SIM Card“. To load the data into the target radio the following command needs to be executed;

03#

While the transfer is in progress „Please Wait“ will appear in the display, if the data transfer is completed successfully „Clone“ will appear back in the display.

5. Now the second set of data needs to be loaded onto the „Floppy SIM Card“ from the source radio, to do this repeat step1 to 4.

**IMPORTANT** - On step 2 a new command is needed on the second transfer, at this stage please enter ;

022#.

If at any stage an error occurs an error message will appear in the handset display. If a „Floppy SIM Card“ is removed from a unit before the transfer is complete a „Bad data on Card“ indication will appear and the process should be repeated.

### **Master Cloning Transfer Procedure**

This procedure will be used when a customers radio does not power up or for some other reason a Normal Transfer is not possible. This procedure enables a Service Station to set the replacement transceiver boards to the correct feature set i.e the same as the customers faulty transceiver boards.

1. Select the „Master SIM card“ that will set the replacement radio to the same feature set as the customers original boards i.e 7 or 9 button handset version.

2. Insert the „Master SIM Card“ into the replacement radio and turn the radio on. „Clone“ should now appear in the display and the radio is ready to be set to the correct mode.

3. The command to program the radio to the correct mode is

03#.

When this command is entered „Please Wait“ will appear in the display, if the programming is completed successfully then „Clone“ will reappear in the display.

**Note: At no point should either 021# or 022# be entered into the phone when a Master SIM card is in the phone. If either of these commands are entered the contents of the Master SIM card will be lost.**

To prevent the above from happening there are 2 extra commands available that „Lock“ the Master SIM Card and prevent you writing onto the card, the commands are:

**06# - „Lock“ SIM Card**

This will prevent the overwriting of the card with the 02x # commands.

**07# - „Unlock“ SIM Card**

This command will allow you to write data onto the SIM card using the 02 X # commands if the card was previously locked using the 06# command.

**Master SIM Card Creation**

If in the future a Master SIM card needs to be replaced with a new Master SIM card to set a new radio to a new feature set, then an old Master SIM card is no longer required and can be updated to program new radio's. This is done by inserting the „Floppy SIM“ into a new radio programmed with the new feature set and turning the radio on. „Clone“ will appear in the display, then enter the command

024#.

This will then programme the „Floppy SIM“ into Master SIM card mode for that particular feature set of that transceiver. While programming is taking place „Please Wait“ will appear in the display and „Clone“ will appear when the transfer is complete. The SIM card can now be used for setting replacement transceivers to the correct feature set for the new model.

Below are short examples of the 3 different procedures.

### **Normal Transfer**

1. Power up source radio (faulty radio) & the replacement radio.
2. Insert Floppy SIM card into source radio.
3. Enter command 021#.
4. Remove SIM Card.
5. Insert SIM Card into good radio (Target radio).
6. Transfer data into target radio, enter command 03#.
7. Remove SIM Card.
8. Repeat steps 2 to 7, except on step 3 enter 022# instead of 021#.

### **Master Transfer**

1. Power up replacement radio.
2. Insert Master SIM into radio.
3. Enter command 03#.
4. Remove SIM Card.

### **Creating Master SIM Cards**

1. Power up new model radio.
2. Insert SIM Card into radio.
3. Enter command 024#.
4. Remove SIM Card.

The part numbers for the „Floppy SIM cards“ are as follows;

<b><u>Description</u></b>	<b><u>Part No</u></b>
„Floppy SIM Card“ Normal Transfers (Mobile)	5104025 D01
„Floppy SIM Card“ Normal Transfers (Portable )	5104025 D03
„Floppy SIM Card“ for Master Transfers (Mobile)	5104025 D02
„Floppy SIM Card“ for Master Transfers (Portable)	5104025 D04

When ordering Master SIM Cards please indicate what Package No it needs to be set too. i.e S2600AAB.

The package number can be found on the SIM Card reader end of the mobile transceiver or on the back housing of the Portable.

## SERVICING THE GSM PORTABLE

This section will cover how to exchange the boards inside a faulty radio and replace them with good boards from the Service radio.

1. Once it has been decided that the Portable is faulty and the transceiver boards need replacing then you first of all need to ensure that the replacement boards are set correctly to work with the same set of features as the customers original unit, so if you do not have in stock a Service Transceiver the same as the customers then the service transceiver needs to be set correctly, **this is done via the Personality Transfer procedure described in Section 7.**

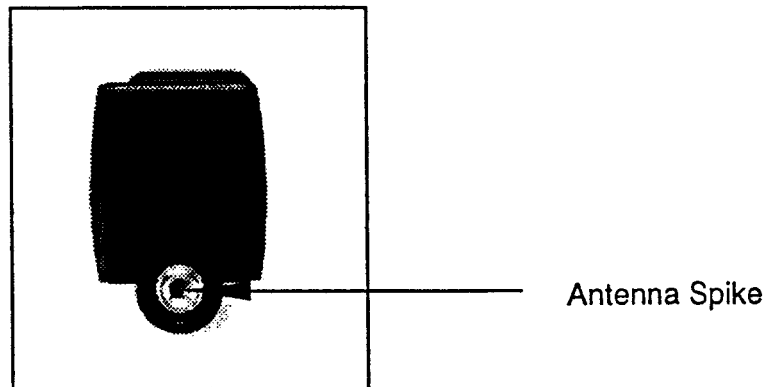
Note: The Service Transceiver will be defaulted to the English Language Prompts, therefore if another language is required it will have to be selected via the menu options available in the phone.

It is advised that you complete a Personality Transfer before exchanging the boards to avoid confusion between which has the good board in and which has the faulty board in. To ensure the Service transceiver is functioning it is advised a test call is made on the Service Transceiver before it is disassembled with a Test SIM card or the customers SIM card.

2. If a Personality Transfer is required after it is completed it will then be necessary to disassemble the unit to exchange the electronic assembly (internal boards), the disassembly of the units is described below;

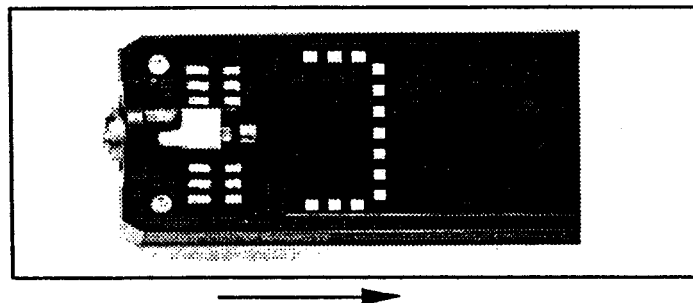
### DISASSEMBLY

- a) Remove the antenna spike from the antenna connector, use special tool (Part No 6680321B58 - Antenna Bushing Tool) as shown in Fig 1.



- b) Slide off CVC block clip as shown below in Fig 2.

Fig 2



## SERVICING THE GSM PORTABLE

c) Remove the four corner screws using a Torx Screwdriver with a Torx Bit, size 9, as shown in Fig 3.

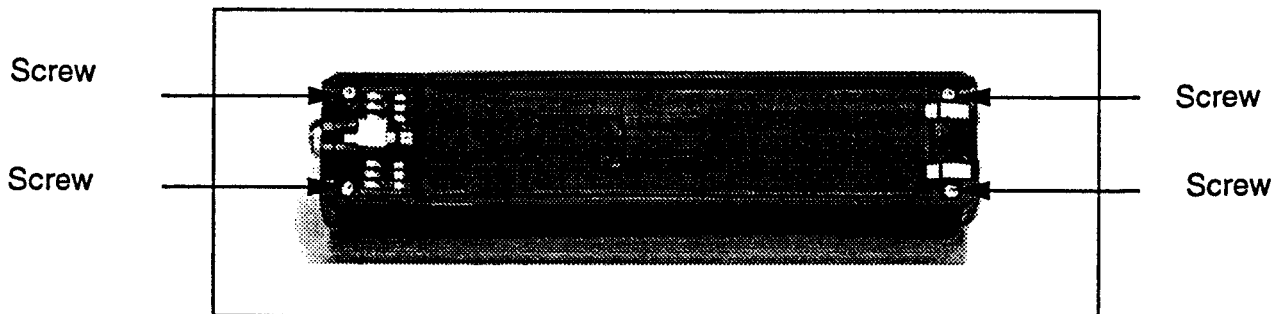


Fig 3

The front housing will now be separated from the back housing. Simply pull the two housings apart. When separating the two it is easier to gently press the Antenna block down as you pull the back housing off.

**Note: Be careful to not pull apart the housings too hard as you may damage the flex that connects the card reader to the CVC block connector.**

d) You will now see one side of the RF board, on this board are five screws, three of which need to be removed to separate the boards from the front housing. The three screws are shown in the following diagram Fig 4, once these have been removed using a Torx Screw driver Size 9, the Transceiver boards can be pulled away from the front housing.

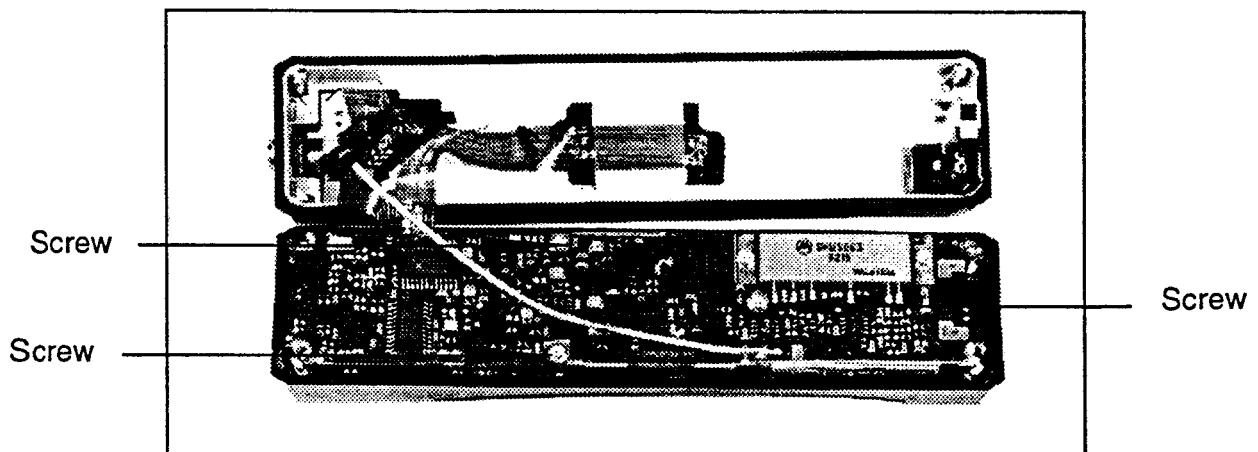


Fig 4

When pulling the transceiver boards out of the front housing, the two boards may come apart, if this happens, simply put the two boards back together. There is a Male and Female connector on each board at each end of the boards which need to be aligned before pushing the boards back together.

**Note: Do Not pull apart the boards from the front housings too far as you may damage the Microphone which is held in the front housing on two short wires in a rubber gromet.**

e) The rubber gromet can be removed from the front housing by pulling it out.

## SERVICING THE GSM PORTABLE

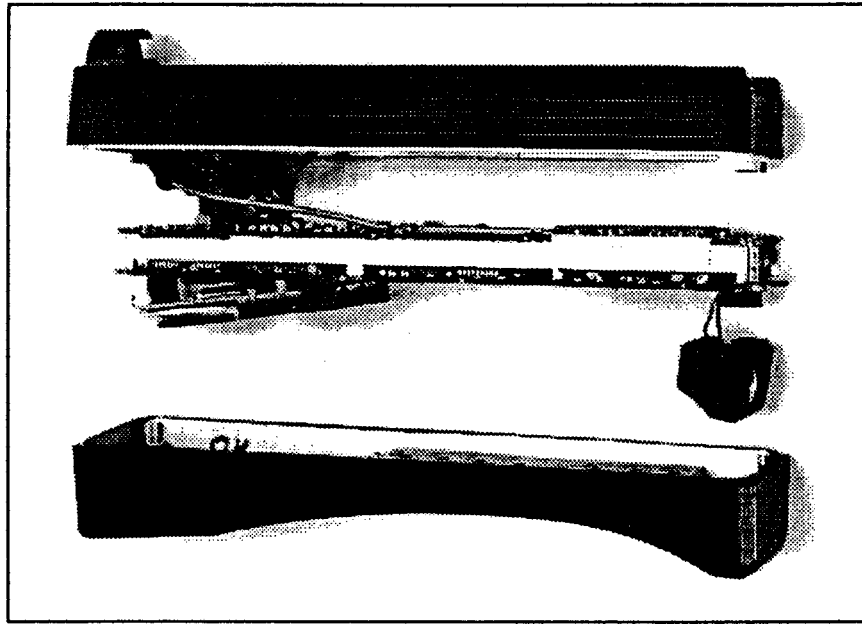


Fig 5

The above diagram, Fig 5, shows what the Portable looks like when disassembled.

The above Disassembly process needs to be repeated for the other Portable that has not yet been disassembled. Once both units have been disassembled the Transceiver boards and back housings need to be swapped over.

The customer should keep their original Front Housing and keypad, everything else in effect will be replaced.

Therefore being returned either to the Hi-Tech Centre or the National repair centre will be a unit that is made up of the customers back housing and Transceiver boards and the Front housing marked 'SERVICE' and the keypad from the Service front housing.

### ASSEMBLY

To re-assemble both the customers unit, now with the good replacement boards in, and the 'Service' transceiver with the faulty boards in the following steps must be taken.

- a) Place back into place the rubber grommet containing the Mic, the rubber grommet will only fit back into the front housing in one way.
- b) Then place the transceiver boards back into the front housing, ensuring the cable for the Mic does not become trapped. When the Mic is replaced into the Grommet please ensure the Positive and negative wires are twisted together. The boards should be placed back into the front housing as shown in Fig 5., with the CVC block connector at the dispaly end of the front housing and the blue RF PA at the Mic end of the front housing. Also ensure that the flex cable between the CVC block connector and the logic board is not twisted or broken.
- c) Once the transceiver boards are in place in the front housing, they can be screwed into place you need to replace the three screws removed earlier, these three are shorter than the four used to hold the back housing to the front housing.

The three screws that hold the transceiver boards onto the front housing are shown in Fig 4.

## **SERVICING THE GSM PORTABLE**

d) Once these three screws have been put in place the back housing can be put in place, this is best done by pushing the antenna end down first, ensuring the antenna block fits through the hole in the back housing. The best way to ensure this happens is to move the antenna switch block with your hand so that it fits through the hole.

e) The next step is to replace the four corner screws in the back housing, while doing this please ensure the front and back housings are held tightly together. The four screws should be tightened.

f) The CVC block retaining clip now needs to be slid back into place, you may require a small tool to push the clip over the first ridge, if a tool is required please use a tool that will not mark the back housing. When sliding the clip onto the CVC block you may need to raise the CVC block a few millimeters to slide the clip back into its correct position.

g) The last step is to replace the antenna spike.

The Portable is now ready to return to the customer, and the Service unit back to the Hi-Tech centre or the National Repair Centre. There is no need for any labels to be changed on either of the phones.

## Fault codes

- 1) ANTENNA: Cracked or broken antenna, any antenna related faults.
- 2) DROP CALLS: Dropping of calls due to low power, frequency error.
- 3) SHORT BATTERY LIFE: Any faults relating to the battery.
- 4) POWER FAILURE: No power up, faulty power up (software), faulty charger output, accessory output failure.
- 5) NO RX/TX: No receipt or transmission due to poor RX sensitivity, no power output, transmitter failure.
- 6) NO DISPLAY: Failure of digits to appear in display, display LED/LCD not lighting.
- 7) MECHANICAL: Any faults relating to housings- hardware connectors being broken, cracked or loose/not connected. Wires/leads being broken or crushed.
- 8) NO KEYPAD OPERATION: Keypad fails to operate (i.e. no keypad tone confirmation or digit appearing in display).
- 9) UPGRADE: All units returned for software upgrades or reprogramming and units sent in for product enhancements.
- 10) MISCELLANEOUS: Any faults not covered by any of the other codes.
- 11) POOR AUDIO: All audio related faults, such as mic/speaker.



## Repair codes

- |                         |  |
|-------------------------|--|
| 1) NO FAULT FOUND:      | Any unit where no repair or adjustment was necessary.                                      |
| 2) UPGRADE:             | Units that have been enhanced or software upgraded.  |
| 3) RE-PROGRAM/RE-PHASE: | Units that have been reprogrammed or required re-phasing.                                  |
| 4) PART REPLACED:       | Units that require a part to be replaced, excluding any PCB's.                             |
| 5) UNIT REPLACED:       | Replacement of a complete transceiver or mobile kit.                                       |
| 6) MAIN PCB REPLACED:   | Any unit that requires its main PCB to be replaced (this does not include display boards). |
| 7) MECHANICAL REPAIR:   | Replacement of any mechanical parts (i.e. antennas or transportable or handheld housings). |
| 8) MISCELLANEOUS:       | Any repairs not covered by any of the other codes.   |
| 9) PCB REPLACED:        | Replacement of secondary PCB's (display boards, etc.).                                     |

## **LEVEL 1 & 2**

## **SPARE PARTS LIST**

**PCM-D300, MOBILE PARTS LIST**

DESCRIPTION	PARTSNR.
Replacement Handset Part No (BIC 3.0)	SCN2487A
Housing Top/Lens Assembly	0109676J02
Keypad Mobile GSM	3809675J01
Bottom Housing	1509917F01
Earpiece speaker	5084520R03
Handset Microphone	0109013A58
Volume Control	0109874G01
Coil Cord	3009637H02
B Handset PCB	CCLN4192A
Escutcheon Transportable	1309746B32
Service Tcwr (8W, BIC 3.0)	SUF1331A
SIM Card Reader	5302108Z02
Antenna Assembly	3002109Z02
Transceiver Housing	1502685Z01
Hangup Cup Mounting Bracket	CCRN4000A
Eliminator Box	CCLN7023A
Handset Ext Cable 5M	CCKN4026A
Antenna Hardware	CCRN4001A
Hangup Cup	CCLN4206A
Handsfree Speaker	CCSN4002A
Handsfree Microphone	SMN4012E
Carton Box	5609974K01

**PCA-400, TRANSPORTABLE PARTS LIST**

DESCRIPTION	PARTSNR.
Transportable Cassette	CCLN2123B
Euro Plug Transformer	SPN4055A
Cigarette Lighter Adaptor	SLN8003A

**PCH-D600, PORTABLE PARTS LIST**

DESCRIPTION	PARTSNR.
Front Housing w/Lens	0109924B07
Keypad	3809677J01
Nameplate / Escutcheon	3309935B16
Antenna Bushing (Antenna Spike)	4383927P03
Antenna Retaining Nut	0283202P01
CVC Block Clip	4283943P01
Transformer Euro Plugs	SPN4034A
Overnight Charger Base	SPN4047A
Rapid Charger	RCPCH600
Travel Charger	SLN5973A
DHFA Slide Adaptor	SLN3045A
Handsfree Mic	SMN4012E
Handsfree Speaker	SSN4255B
Hangup Cup	SLN5509A
Power Cable & Fuse Kit	SKN4370A
Control Cable	SKN4326A
Mounting Hardware	SLN5565B
Hangup Cup Mounting Bracket	CCRN4000A
Cable DHFA Slow Charger	SKN4327A
Travel Charger	SLN5973A
Service Tcwr (2W)	S3425A
Carton Box	5609955G10

**TOOLS AND JIGS**

DESCRIPTION	PARTSNR.
TEST BOX (BIC 3.0)	CCUE2172B
Test SIM Card	8102430Z02
Floppy SIM card Normal Transfers (PCM-D300)	5104025D01
Floppy SIM card Normal Transfers (PCH-D600)	5104025D03
Antenna Bushing Tool	6680321B58

**APPENDIX A**

**GLOSSARY OF DEFINITIONS**

**AND ABBREVIATIONS**

Abbreviation	Definition
I/O	Input/Output
IMSI	International Mobile Subscriber Identity
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
K	Kilo ( 1000 )
Kb	Kilo-bit
Kbps	Kilo-bits per second
KHz	Kilohertz
Ki	Encryption Session Key
LCD	Liquid Crystal Display
Lsi	Large Scale Intergration
M	Mega ( 1,000,000 )
MLSE	Maximum Likelihood Sequence Estimator
MMI	Man Machine Interface
MS	Mobile Station
MSC	Mobile Services switching Centre
MTBF	Mean Time Between Failures
NMT	Nordic Mobile Telephone
O&M	Operations and Maintenance
OBL-C	German Cellular System
OMC	Operations and Maintenance Centre
p-p	Peak to Peak
PA	Power Amplifier
PCB	Printed Circuit Board
PCH	Paging CHannel
PCM	Pulse Code Modulation
PEP	Peak Envelope Power
PIN	Personal Identification Number
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
RA	Rural Area profile
RACH	Random Access CHannel
RAND	Authentication Algorithm Random Challenge
Rec	Reccommendation
RF	Radio Frequency
RLR	Receiving Loudness Rating
rms	Root Mean Square
RPE-LPC	Regular Pulse Excited Linear Predictive Coding
RPE-LPC-LTP	RPE-LPC Long Term Predictor

<b>Abbreviation</b>	<b>Definition</b>
RTSG	Radio Telephone Systems Group
Rx	Receive
SACCH	Slow Associated Control Channel
SDCCH	Stand alone Dedicated Control Channel
SIM	Subscriber Identity Module
SLR	Sending Loudness Rating
SMS	Short Message Service
SNR	Signal to Noise Ratio
SRES	Authentication Algorithm Signed Response
TACS	Total Access Communications System
TBD	To be Determined
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TMSI	Temporary Mobile Subscriber Identity
TU	Typical Urban Profile
Tx	Transmit
UART	Universal Asynchronous Receiver and Transmitter
USDC	United States Digital Cellular
VAD	Voice Activity Detector
VLR	Visitor Location Register
W	Watt
uS	Micro-Second